

Integrative taxonomy reveals the *Caridina clinata* Cai, Nguyen & Ng, 1999 species complex (Crustacea, Decapoda, Atyidae), with descriptions of eight new species from Hainan Island, China

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Abstract

Integrative analyses revealed that *Caridina clinata* Cai, Nguyen & Ng, 1999 represents a species complex comprising nine sibling species distributed across Hainan Island (China) and Vietnam. Among these, *C. clinata* sensu stricto (the nominal species itself) occurs in both regions, *C. haivanensis* is endemic to Vietnam, and the seven newly described species are endemic to Hainan Island. Evidence showed that the *C. clinata* population reported by Cai (2014) from Wuzhishan was actually a new species, herein described as *C. caii* **sp. nov.** This study documents nine *Caridina* species from Hainan Island, including eight new species and one newly recorded species. The new species are: *C. wenchangensis* **sp. nov.**, *C. qiongzongensis* **sp. nov.**, *C. huangi* **sp. nov.**, *C. hepingensis* **sp. nov.**, *C. fontinalis* **sp. nov.**, *C. tunchengensis* **sp. nov.**, *C. brevilineata* **sp. nov.**, and *C. caii* **sp. nov.** Additionally, *Caridina clinata* is recorded for the first time from Ledong, Hainan, and is redescribed herein. For each species, we provide comprehensive morphological descriptions, illustrations, taxonomic notes, habitat parameters, and IUCN threat assessments. Furthermore, we clarify the phylogenetic relationships between the newly discovered species and their congeners.

Key Words

16S, COI, Hainan Island, Integrative taxonomy, morphology, new species

Introduction

Hainan Island (18°10'–20°10'N, 108°37'–111°03'E), covering an area of 33,900 km², is a continental island in the South China Sea. The island is separated from China's Leizhou Peninsula by the narrow and shallow Qiongzhou Strait (Zhao et al. 2007; Liang 2018). Also, it lies off the eastern coast of Vietnam across the Beibu Gulf. It is the second largest island in China, after Taiwan Island.

Hainan Island's topography, marked by a high central region and lower surroundings, gives rise to a radial river system draining into the sea. The three principal rivers – the Nandu, Changhua, and Wanquan – drain a combined area of over 3,000 km², representing about 47% of the island's total area (Su et al. 2023). Hainan Island is a biodiversity hotspot within the South-Central China region (Myers et al. 2000; <https://www.britannica.com/science/hot-spot-ecology>). Its biodiversity, characterized

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by abundant endemic species, stems from its dynamic geological evolution and climatic variability, combined with spatially heterogeneous habitats that span marine, brackish, and freshwater ecosystems (Huang et al. 2023).

Caridina H. Milin-Edwards, 1837 is the largest genus of the family Atyidae, with more than 345 species inhabiting brackish to freshwater worldwide except Antarctica and predominantly in the Indo-Pacific regions (De Grave and Fransen 2011; De Grave et al. 2023). Playing a significant role in the freshwater ecosystem, *Caridina* species are a controlling group in food webs because they serve as intermediate bridges, linking the production of periphyton and detritus with higher trophic groups (Crowl et al. 2001; Weber and Traunspurger 2016). Significant extinction risks are now faced by species of *Caridina* due to anthropogenic pressures, such as habitat degradation caused by urbanization, deforestation, agriculture, and hydroelectric projects, as well as natural threats like climate change and sea-level rise (Hou et al. 2024; Kunjulakshmi and Prakash 2025). Many may go extinct even before discovery or formal description (De Grave et al. 2015). Collecting essential taxonomic, distributional, ecological, and life history data for these taxa is an urgent and invaluable undertaking. The pioneering study on *Caridina* from Hainan Island was carried out by Yu (1936), who reported *Caridina nilotica gracilipes* De Man, 1892 and *C. lanceifrons* Yu, 1936. Liang and Yan (1983) described another two species, *C. macrophora* Kemp, 1918 and *C. hainanensis* Liang & Yan, 1983. *C. hainanensis* was subsequently treated as a junior synonym of *C. propinqua* De Man, 1908 (Cai and Shokita 2006). Liang (2004) recorded four *Caridina* species from Hainan Island in the monograph on Order Decapoda, Family Atyidae: *C. gracilipes*, *C. macrophora*, *C. hainanensis* and *C. longirostris*. An important taxonomic revision of freshwater atyid shrimps from Hainan was carried out by Cai (2014), who confirmed seven species of *Caridina*, including one new species, *C. baoting* Cai, 2014, and two new records, *C. clinata* Cai et al., 1999, and *C. elongapoda* Liang & Yan, 1977. Recently, Hou et al. (2024) described two new species: *C. wangan* Hou, Zhang & Guo, 2024 and *C. lineatus* Hou, Zhang & Guo, 2024 and documented the distribution of *C. cantonensis* Yu, 1938 in Hainan. In summary, 11 *Caridina* species were known from Hainan.

The identification of *Caridina* species remains challenging due to their pronounced interspecific morphological similarity and high intraspecific variation – particularly when systematic studies rely solely on morphological comparisons (Wood et al. 2018). However, advances in molecular taxonomy have revolutionized species delimitation, prompting the widespread adoption of integrative taxonomic approaches. This approach is particularly valuable for delineating species boundaries within the genus *Caridina*, where it effectively uncovers misidentifications, cryptic species, and species complexes (De Mazancourt et al. 2018). Consequently, molecular studies are expected to provide a more accurate depiction of species diversity and phylogenetic relationships.

Caridina clinata Cai et al., 1999 was originally described from Cuc Phuong National Park, Ninh Binh Province, northern Vietnam. A decade later, *C. haivanensis* Do & Dang, 2010 – a congener closely related to *C. clinata* – was described from the Hai Van Mountain Pass in central Vietnam (Do and Dang 2010).

Comprehensive analyses revealed that *C. clinata* represents a species complex composed of 9 sibling species. Phylogenetic analyses based on 16S rRNA and mtDNA COI genes support the monophyly of *C. clinata* complex, which comprises 9 distinct, well-supported clades. Among these, *C. clinata* has a distribution spanning China and Vietnam; *C. haivanensis* is restricted to Vietnam; and the remaining seven newly described species: *C. wenchangensis* sp. nov., *C. qiongzongensis* sp. nov., *C. huangi* sp. nov., *C. hepingensis* sp. nov., *C. fontinalis* sp. nov., *C. tunchengensis* sp. nov., and *C. brevilineata* sp. nov. – are endemic to Hainan Island, China.

Cai (2014) assigned specimens from Wuzhishan to *Caridina clinata*, noting their morphological resemblance to *C. lanceifrons*. Our comparative analysis of newly collected material from the same site with *C. clinata* populations from Vietnam and Ledong demonstrates that the Wuzhishan population is distinct from both *C. clinata* and *C. lanceifrons*. Consequently, we describe it herein as a new species, *C. caii* sp. nov. Overall, this study describes nine *Caridina* species from Hainan, including eight new species: *C. wenchangensis* sp. nov., *C. qiongzongensis* sp. nov., *C. huangi* sp. nov., *C. hepingensis* sp. nov., *C. fontinalis* sp. nov., *C. tunchengensis* sp. nov., *C. brevilineata* sp. nov., and *C. caii* sp. nov.; and one previously known species, *C. clinata*. This updates the total number of known *Caridina* from Hainan to 19. The sampling stations where these species were collected are provided (Fig. 1, Table 1). For each new species, we present morphological diagnoses, microhabitat parameters, and IUCN threat assessments. Our findings underscore a close phylogenetic relationship between *Caridina* species from Hainan and their Vietnamese congeners, inferring possible historical biogeographic linkages between Hainan Island and Vietnam and highlighting shared evolutionary trajectories that may have shaped the *Caridina* radiation. These results significantly enhance our knowledge of regional biodiversity.

Materials and methods

Specimen collection, examination and preservation

Specimens were collected from 14 sites across Hainan Island, China (12 sites) and Vietnam (2 sites, representing the topotypic material of *Caridina clinata* and *C. haivanensis*) between 2023 and 2025. Sampling sites and associated site-specific information per site are presented in Fig. 1 and Table 1. Collections employed sturdy, long-handled, fine-meshed dip nets (mesh size 0.6 mm) and baited traps. Specimens were placed in oxygenated polyethylene

Table 1. Sampling localities data and species collected at each site (Sites 1–12: Hainan Island; Sites 13–14: Vietnam; ANC: Ammonia Nitrogen Content; DO: Dissolved Oxygen Content; WP: Water pH).

Site	Locality	Date of sampling	ANC mg/L	DO mg/L	WP pH	Coordinates	Altitude m	Microhabitat profile	Water current	Composition species
1	Baoyou Town, Ledong County, Hainan	27 Mar 2024, 5 Mar 2025, 19 Jul 2025	0.02	6	7.4	18°49'48"N, 109°7'58"E	306	Rocky, muddy, aquatic plants	Slow	<i>C. clinata</i> , <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i> , <i>Hainanpotamon daiae</i>
2	Baoyou Town, Ledong County, Hainan	5 Mar 2025, 19 Jul 2025	0.03	5	7.3	18°44'50"N, 109°2'27"E	331	Rocky, gravel, muddy	Slow	<i>C. clinata</i> , <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i> , <i>Hainanpotamon daiae</i>
3	Jianfeng Town, Ledong County, Hainan	5 Mar 2025, 19 Jul 2025	0.02	5	7.3	18°45'6"N, 109°2'11"E	400	Rocky, muddy, leaf litter	Slow	<i>C. clinata</i> , <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i> , <i>Hainanpotamon daiae</i>
4	Shuiman Xiang, Wuzhishan City, Hainan	28 Jan 2024, 19 Jul 2025	0.01	6	6.7	18°54'15"N, 109°37'33"E	643	Gravel, sandy, leaf litter	Intermediate	<i>C. caii</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i>
5	Chongxing Town, Wenchang City, Hainan	22 Jan 2024	0.05	5	6.8	19°26'43"N, 110°34'39"E	72	Gravel, muddy, leaf litter	Slow	<i>C. lanceifrons</i> , <i>C. wenchangensis</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Hainanpotamon fuchengense</i> , <i>Gambusia affinis</i> , <i>Oreochromis niloticus</i>
6	Yinggen Town, Qiongzhang County, Hainan	23 Jan 2024	0.02	6	7.2	19°1'26"N, 109°50'27"E	312	Rocky, sandy, leaf litter	Intermediate	<i>C. lanceifrons</i> , <i>C. qiongzhangensis</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i>
7	Yinggen Town, Qiongzhang County, Hainan	23 Jan 2024	0.05	6	7.2	19°1'56"N, 109°47'26"E	336	Big rocky, gravel, muddy	Intermediate	<i>C. lanceifrons</i> , <i>C. qiongzhangensis</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i>
8	Heping Town, Qiongzhang County, Hainan	17 Jan 2024, 30 Jul 2025	0.03	6	7.1	18°56'39"N, 109°57'1"E	242	Rocky, leaf litter, aquatic plants	Intermediate	<i>C. huangi</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i>
9	Yinggen Town, Qiongzhang County, Hainan	15 Aug 2023, 30 Jul 2025	0.04	6	6.9	18°52'58"N, 110°0'55"E	147	Rocky, sandy	Slow	<i>C. hepingensis</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Neotiwariopotamon whiteheadi</i>
10	Longtang Town, Qiongzhang District, Haikou City, Hainan	17 Jan 2025	0.05	5	6.8	19°55'4"N, 110°24'45"E	16	Rocky, muddy	Slow	<i>C. lanceifrons</i> , <i>C. fontinalis</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Hainanpotamon fuchengense</i>
11	Tuncheng Town, Tunchang County, Hainan	18 Jan 2025, 30 Jul 2025	0.06	7	6.8	19°28'23"N, 110°6'21"E	181	Rocky, muddy, leaf litter, aquatic plants	Slow	<i>C. tunchengensis</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Hainanpotamon fuchengense</i> , <i>Neotiwariopotamon whiteheadi</i>
12	Huishan Town, Qiongzhang City, Hainan	1 May 2025, 30 Jul 2025	0.04	6	7.2	19°6'42"N, 110°11'49"E	61	Big rocky, gravel, leaf litter, aquatic plants	Intermediate	<i>C. brevilineata</i> sp. nov., <i>Apotamonautes hainanensis</i> , <i>Hainanpotamon fuchengense</i> , <i>Neotiwariopotamon whiteheadi</i> , <i>Oreochromis niloticus</i>
13	Cuc Phuong National Park, Ninh Binh Province, Vietnam	5 Mar 2025	/	/	/	20°19'11"N, 105°37'42"E	293	Sandy	Slow	<i>C. clinata</i> , <i>Potamiscus cuphuongense</i> , <i>Potamiscus kimboiense</i>
14	Tho Quang, Da Nang Province, Vietnam	10 Jul 2025	/	/	/	16°6'46"N, 108°15'25"E	26	Sandy	Slow	<i>C. haivanensis</i>

bags, anesthetized with ice, and transported to a temporary field facility. Upon arrival, specimens were photographed and fixed in 95% ethanol. After 24 hours, the ethanol was replaced with 75% ethanol for long-term storage. Specimens were subsequently preserved in 75% ethanol for morphological examination and molecular analysis.

Additional fieldwork activities included observing live individuals in their natural habitats, recording GPS coordinates, and photographing habitats. Vouchered specimens were deposited in the collection of Foshan University (FU).

Morphological study

Specimens were examined using a dissecting microscope (Olympus SZX7). Morphometric measurements of selected characters and illustrations were obtained using a digi-

tal camera (DP22) mounted on a stereomicroscope (Olympus SZX7) and Olympus CellSens Entry v1.18 software.

The following abbreviations are used throughout the text: tl (total length, measured from the rostral tip to the posterior margin of the telson); cl (carapace length, measured from the postorbital margin to the posterior margin of the carapace); rl (rostral length, measured from the rostral tip to the postorbital margin); al (altitude); stn (sampling station). All measurements are in millimeters. Notation for the rostral formula follows that of Chace and Bruce (1993).

Molecular analyses

Genomic DNA was extracted from abdominal muscle tissue using the Easy-Pure Genomic DNA Kit (TransGen Biotech, Beijing, China), following the manufacturer’s

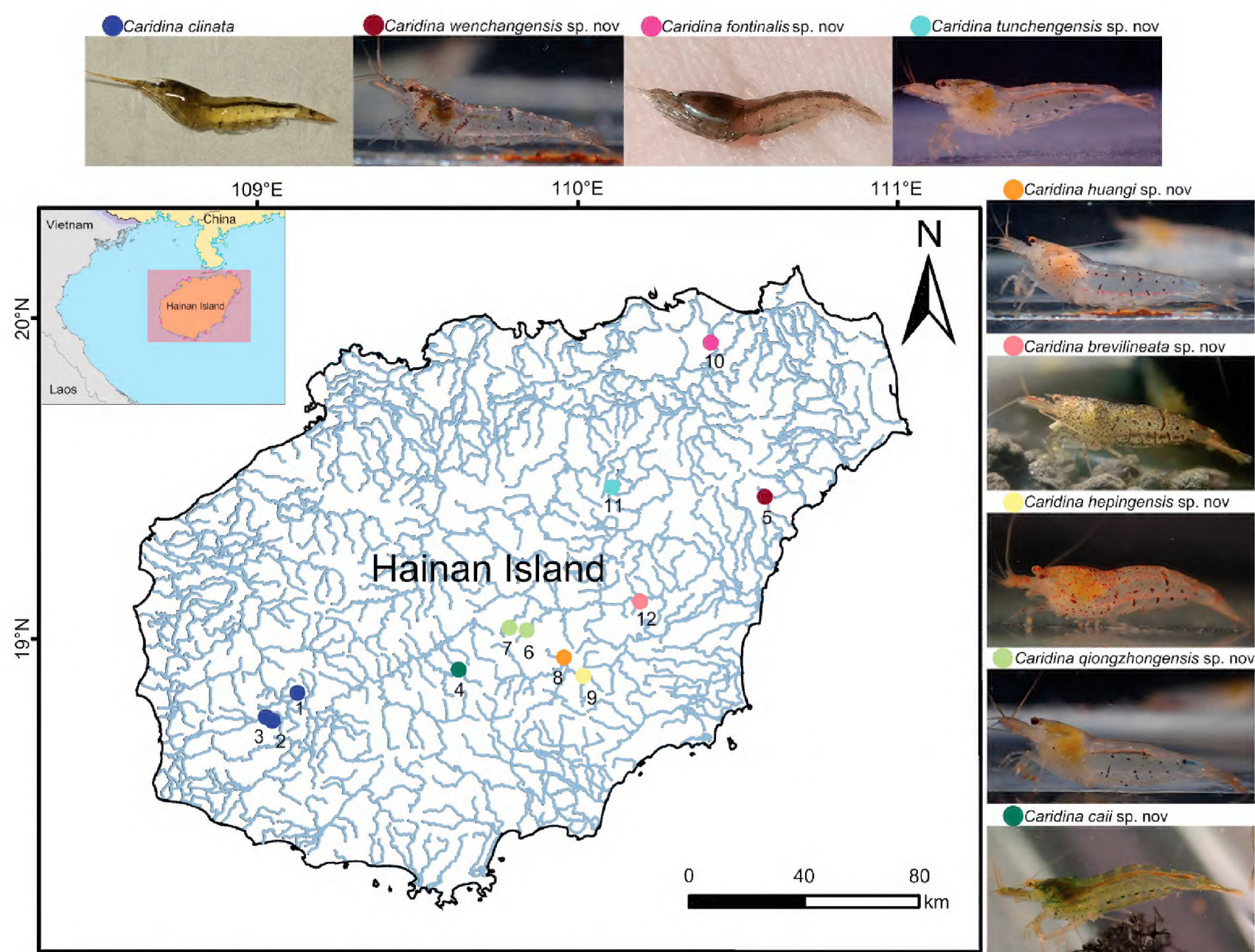


Figure 1. Collection sites of Hainan Island and live colouration of 9 *Caridina* species.

instructions. Two loci were selected for analysis: cytochrome c oxidase subunit I (Folmer et al. 1994), 16S ribosomal RNA gene (von Rintelen et al. 2007). The primers used for COI amplification were LCO1490 (GGTCAA-CAAATCATAAAGATATTGG) and HCO2198 (TA-AACTTCAGGGTGACCAAAAATCA); for 16S rRNA, primers were 16S-F-Car (TGCCTGTTTAT-CAAAACATGTC) and 16S-R-Car1 (GAAAGATAGAACTAACCTGGCT). These primer pairs were used to amplify all *Caridina* specimens in this study, with 2 outgroup species (*Neocaridina palmata* Shen, 1948 and *Macrobrachium rosenbergii* Deman, 1879) for comparison. PCRs were run in 50 µl volume reactions.

The PCR reactions were performed in 50 µL reaction volume using a Bio-Rad T100 Thermal Cycler. The reaction mixture contained 25 µL of 2 × EasyTaq Mix, 20 µL of ddH₂O, 2 µL of each of the forward and reverse primers, and 1 µL of the DNA template. The PCR amplification protocol was as follows: 35 cycles of denaturation at 94 °C for 30 s, annealing at 46 °C for 60 s, extension at 72 °C for 60 s, and a final extension at 72 °C for 5 min. Amplification products were verified via 1.5% agarose gel electrophoresis using 5 µL of each PCR product. Successfully amplified products were sequenced bidirectionally using an Applied Biosystems 3730 Analyzer (Applied Biosystems, Foster City, CA, USA), and consensus sequences were generated by verifying complementary strand.

For phylogenetic analyses, we included sequences of new species, and other *Caridina* species known from

adjacent regions. All nucleotide sequences were aligned using the MUSCLE algorithm in MEGA 7.0 (Kumar et al. 2016). Aligned COI and 16S sequences were trimmed to final lengths of 490 bp and 473 bp, respectively. The GTR + G + I model was selected as the optimal substitution model for both loci based on the Akaike Information Criterion (AIC) in jModelTest. The two loci were concatenated using the Concatenate Sequence function in PHYLLOSuite 1.2.3.

Phylogenetic tree was concatenated from the concatenated data using maximum likelihood (ML) in MEGA 7.0 (Kumar et al. 2016). ML analyses were run with two gene partitions (COI and 16S) under the GTR + G + I model, and branch support was assessed via 1,000 bootstrap replicates. Genetic distances were calculated using MEGA 11 (Stecher et al. 2020; Tamura et al. 2021). All new sequences generated in this study have been deposited in GenBank (see Table 2).

Conservation status

The conservation status of shrimp species treated herein was assessed in accordance with the “Guidelines for Using the IUCN Red List Categories and Criteria” from IUCN (<https://www.iucnredlist.org/>). These guidelines evaluate a species’ extinction risk in the near term through assessments of its geographic distribution, population trends, and existing as well as projected threats.

Table 2. Specimens of atyid taxa used for DNA sequencing.

Species	Specimen catalog	GenBank	GenBank	Collection data	References
		COI	16S		
<i>Caridina ablepsia</i>	FU416700002	PV535551	PV541512	Yongshun, Hunan, China	this study
<i>Caridina baoting</i>	HN1008	PQ901512	PQ932204	Baoting, Hainan, China	this study
<i>Caridina breviata</i>	FU529236002	PV535549	PX269290	Taishan, Guangdong, China	this study
<i>Caridina brevilineata</i>	FU5714026	PV940554	PV940425	Qionghai, Hainan, China	this study
	FU5714027	PV940555	PV940426		this study
	FU5714028	PV940556	PV940427		this study
<i>Caridina caii</i>	FU5722002	PV535542	PV541503	Wuzhishan, Hainan, China	this study
	FU5722003	PV940541	PV940411		this study
	FU5722004	PV940542	PV940412		this study
<i>Caridina cantonensis</i>	HN1011	PQ901515	PX248637	Wenchang, Hainan, China	this study
<i>Caridina clinata</i>	FU70000001	PV940539	PV940409	Cuc Phuong, Ninh Binh, Vietnam	this study
	FU70000002	PV940540	PV940410		this study
	FU5725002	PV535540	PV541501	Ledong, Hainan, China	this study
	FU5725003	PV940538	PV940408		this study
<i>Caridina fontinalis</i>	FU5700002	PV535547	PV541508	Haikou, Hainan, China	this study
	FU5700004	PV940550	PV940421		this study
	FU5700005	PV940551	PV940422		this study
<i>Caridina gracilirostris</i>	FU571521002	PV535552	PV541514	Wanning, Hainan, China	this study
<i>Caridina haivanensis</i>	FU5500001	PV940557	PV940428	Hai Van, Thua Thien-Hue, Vietnam	this study
<i>Caridina hepingensis</i>	FU5727009	PV535546	PV541505	Qiongzong, Hainan, China	this study
	FU5727010	PV940548	PV940419		this study
	FU5727011	PV940549	PV940420		this study
<i>Caridina huangi</i>	FU5727002	PV535545	PV541506	Qiongzong, Hainan, China	this study
	FU5727003	PV940546	PV940417		this study
	FU5727004	PV940547	PV940418		this study
<i>Caridina lanceifrons</i>	FU65	MN701605	MT446450	Dongfang, Hainan, China	this study
	FU5727023	PV940559	PV940429	Qiongzong, Hainan, China	this study
<i>Caridina lineatus</i>	HN1004	PQ901508	PQ932200	Wanning, Hainan, China	Hou et al. 2024
<i>Caridina macrophora</i>	FU538100002	PV535553	PV541515	Nanning, Guangxi, China	this study
<i>Caridina minnanica</i>	FU5290001	PV940560	PV940430	Jiangmen, Guangdong, China	this study
	FU5166001	PV940561	PV940431	Shanwei, Guangdong, China	this study
<i>Caridina qiongzhongensis</i>	FU5727017	PV535544	PV541507	Qiongzong, Hainan, China	this study
	FU5727019	PV940545	PV940415		this study
	FU5727020	PX149318	PV940416		this study
<i>Caridina serrata</i>	FU137	MN701599	MT446454	Zhuhai, Guangdong, China	Chen et al. 2020
<i>Caridina tetrazona</i>	FU, 2017-06-27-03	MN701593	PX149329	Zhuhai, Guangdong, China	Chen et al. 2020
<i>Caridina tricincta</i>	FU532700001	PV535550	PV593959	Longan, Guangxi, China	this study
<i>Caridina tunchengensis</i>	FU5716002	PV535548	PV541509	Tunchang, Hainan, China	this study
	FU5716003	PV940552	PV940423		this study
	FU5716004	PV940553	PV940424		this study
<i>Caridina wangan</i>	HN1001	PQ901505	PQ932198	Wanning, Hainan, China	Hou et al. 2024
<i>Caridina wenchangensis</i>	FU5713002	PV535543	PV541504	Wenchang, Hainan, China	this study
	FU5713003	PV940543	PV940413		this study
	FU5713005	PV940544	PV940414		this study
<i>Caridina zhujiangensis</i>	HN1010	PQ901514	PQ932206	Lingshui, Hainan, China	Hou et al. 2024
<i>Macrobrachium rosenbergii</i>	RV_MI02	MK113940	MK113948	Ruvu, Tanzania	Kuguru et al. 2019
<i>Neocaridina palmata</i>	FUGX240821001	PX248631	PX248630	Jingxi, Guangxi, China	this study

Taxonomy

Family Atyidae De Haan, 1849

Genus *Caridina* H.Milne Edwards, 1837

Caridina clinata Cai, Nguyen & Ng, 1999

Figs 2A, 3, 4

Caridina clinata Cai, Nguyen & Ng, 1999: 531–535, Figs 1, 2 [type locality: Cuc Phuong National Park, Ninh Binh Province, northern Vietnam].

Non *Caridina clinata* Cai, 2014: 207–231, Figs 10, 11.

Materials examined. CHINA – **Hainan Island** • 1 ♂, cl 3.3 mm, (FU5725001); 1 ♂, cl 4.1 mm, (FU5725002); 1 ♂, cl 3.4 mm, (FU5725003); 1 ♂, cl 3.7 mm, (FU5725004); 2 ♂, cl 3.5–4.1 mm, (FU5725005); 1 ♀, cl 5.1 mm, (FU5725006); 1 ♀, cl 4.9 mm, (FU5725007); 1 ovigerous ♀, cl 5.3 mm, (FU5725008), Baoyou Town, Ledong City, 18°49'48"N, 109°7'58"E, al. 306 m, stn. 1, coll. YU W. D., MA X. C. and HOU J. J., 27 Mar 2024; 1 ♀, cl 3.8 mm, (FU5725009); 2 ♂♂, cl 3.9–4.1 mm, (FU5725010), Jianfeng Town, Ledong City, 18°44'50"N, 109°2'27"E, al. 331 m, stn. 2, coll. YU W. D. and HOU J. J., 28 Feb. 2025; 2 ♂♂, cl 4.0–4.2 mm, (FU5725011),

Jianfeng Town, Ledong City, 18°45'6"N, 109°2'11"E, al. 400 m, stn. 3, coll. YU W. D. and HOU J. J., 28 Feb. 2025. VIETNAM – **Ninh Bình Prov.** • 1 ♂, cl 3.5 mm, (FU70000001); 1 ♂, cl 3.6 mm, (FU70000002); 1 ♂, cl 3.9 mm, (FU70000003); 1 ♂, cl 4.4 mm, (FU70000004); 3 ♀♀, cl 3.9–4.9 mm, (FU70000005), Cuc Phuong National Park, 20°19'11"N, 105°37'42"E, al. 293 m, stn. 13, 5 Mar. 2025.

Description. *Body* (Fig. 2A): Small, slender and sub-cylindrical, males up to 4.4 mm cl, females up to 5.3 mm cl. Sixth abdominal somite 0.40–0.53 times as long as carapace.

Rostrum (Fig. 3A): Short, slightly sloping downwards, reaching to the beginning to the end of the second segment of antennular peduncle; 0.4–0.5 of cl; armed dorsally with 12–16 teeth, including 4–6 on carapace posterior to orbital margin, ventrally with 1–5 teeth; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 3A): Well developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 3A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 3B): Stylocerite reaching 0.67–0.93 times as long as basal segment of antennular peduncle; basal segment shorter than combined length of second and third segments, 1.54–1.70 times as long as second segment; second segment 1.12–1.49 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 3C): Scaphocerite 3.1–3.2 times as long as wide, outer margin straight, asetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 3G): Palp of first maxilliped broadly triangular, ending in finger-like projection.

Third maxilliped (Fig. 4B): Basal segment 0.89–1.09 times as long as penultimate segment; penultimate segment as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 6–9 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching beyond the middle of second segment, distal margin with long plumose setae.

First pereopod (Fig. 4C): Chela 2.11–2.38 times as long as high, 1.26–1.42 times as long as carpus; movable finger 3.14–3.92 times as long as wide and 1.02–1.30 times as long as palm, setal brushes well developed; carpus 1.71–2.03 times as long as wide, slightly excavated distally; merus 0.99–1.21 times as long as carpus.

Second pereopod (Fig. 4D): Chela 2.83–3.29 times as long as high, 0.66–0.79 times as long as carpus; movable finger 3.97–4.81 times as long as wide and 1.46–1.58 times as long as palm, setal brushes well developed; carpus 5.42–6.30 times as long as wide, slightly excavated distally; merus 0.81–0.93 times as long as carpus.

Third pereopod (Fig. 4E): Dactylus 3.00–4.20 times as long as wide, terminating in a prominent claw-like

spine surrounded by simple setae, followed by 5–6 spiniform setae; propodus 2.78–4.62 times as long as dactylus, 9.11–10.05 times as long as wide; carpus 0.64–0.70 times as long as propodus; merus 1.41–2.05 times as long as carpus, with 3 spiniform setae on the posterior margin. Ischium sometimes with 1 small movable spiniform setae on the posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

Fifth pereopod (Fig. 4F): Dactylus 4.53–5.71 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 41–51 spiniform setae; propodus 2.94–3.43 times as long as dactylus, 11.53–13.43 times as long as wide; carpus 0.49–0.69 times as long as propodus; merus 1.49–1.73 times as long as carpus, with 2–3 spiniform setae on the posterior margin.

First four pereopods with epipod.

First pleopod (Fig. 4G): Endopod in male 0.46–0.67 times as long as exopod, oblong-reniform, 2.40–3.04 times as long as distally wide, tip rounded; appendix interna well developed, arising from distal 0.33 of endopod, reaching slightly beyond the end of endopod, distally with cincinnuli.

Second pleopod (Fig. 4H): Appendix masculina club-shaped, reaching 0.60–0.70 length of exopod, some short spiniform setae on basal part, and inner margin and tip bearing nearly equal long and stout spiniform setae; appendix interna well developed, reaching 0.52–0.63 length of appendix masculina, distally with cincinnuli.

Telson (Fig. 4I): With 4–5 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin with 4 pairs of intermedial spiniform setae. Exopodite of the uropod (Fig. 4J) bears a series of 18–21 movable spinules along diarsis.

Eggs: 0.65–0.70 mm × 1.07–1.20 mm in diameter.

Remarks. Based on morphological descriptions and measurements above, our specimens from Ledong closely match the original description of *Caridina clinata* Cai et al., 1999. However, some differences between the present material and the type specimens are evident, such as: the more slender carpus of the first pereopod (1.71–2.03 times as long as high vs. 1.2–1.5 in type specimens); the more slender chela (2.83–3.29 times as long as high vs. 2.5 in type specimens) and carpus (5.42–6.30 times as long as high vs. 4.7 in type specimens) of the second pereopod; more spinules on uropodal diarsis (18–21 vs. 14–17 in type specimens). Furthermore, our specimens exhibit a posteromedian telson projection (Fig. 4I), contrasting with the description and illustration by Cai et al., who reported its absence (Cai et al. 1999: Fig. 2A). However, this projection is consistently present in all examined topotypic specimens. Additionally, the scaphocerite length-to-width ratio in our material ranges from 3.10–3.20, aligning with topotypic specimens but differing from the type specimens (3.4). But the *C. clinata* specimens from Hainan Island and those from Vietnam are highly similar in the shape of the male first pleopod endopod and the male appendix masculina



Figure 2. Habitats of 9 *Caridina* species on Hainan Island. **A.** *C. clinata* Cai et al., 1999; **B.** *C. caii* sp. nov.; **C.** *C. wenchangensis* sp. nov.; **D.** *C. qiongzongensis* sp. nov.; **E.** *C. huangi* sp. nov.; **F.** *C. hepingensis* sp. nov.; **G.** *C. fontinalis* sp. nov.; **H.** *C. tunchengensis* sp. nov.; **I.** *C. brevilineata* sp. nov.

of the second pleopod, and show no significant genetic differentiation; thus, we still classify the Ledong population as *Caridina clinata*.

Molecular results. Based on COI and 16S rRNA sequence data (Fig. 21), the genetic divergence between Ledong and Vietnam populations is minimal, ranging

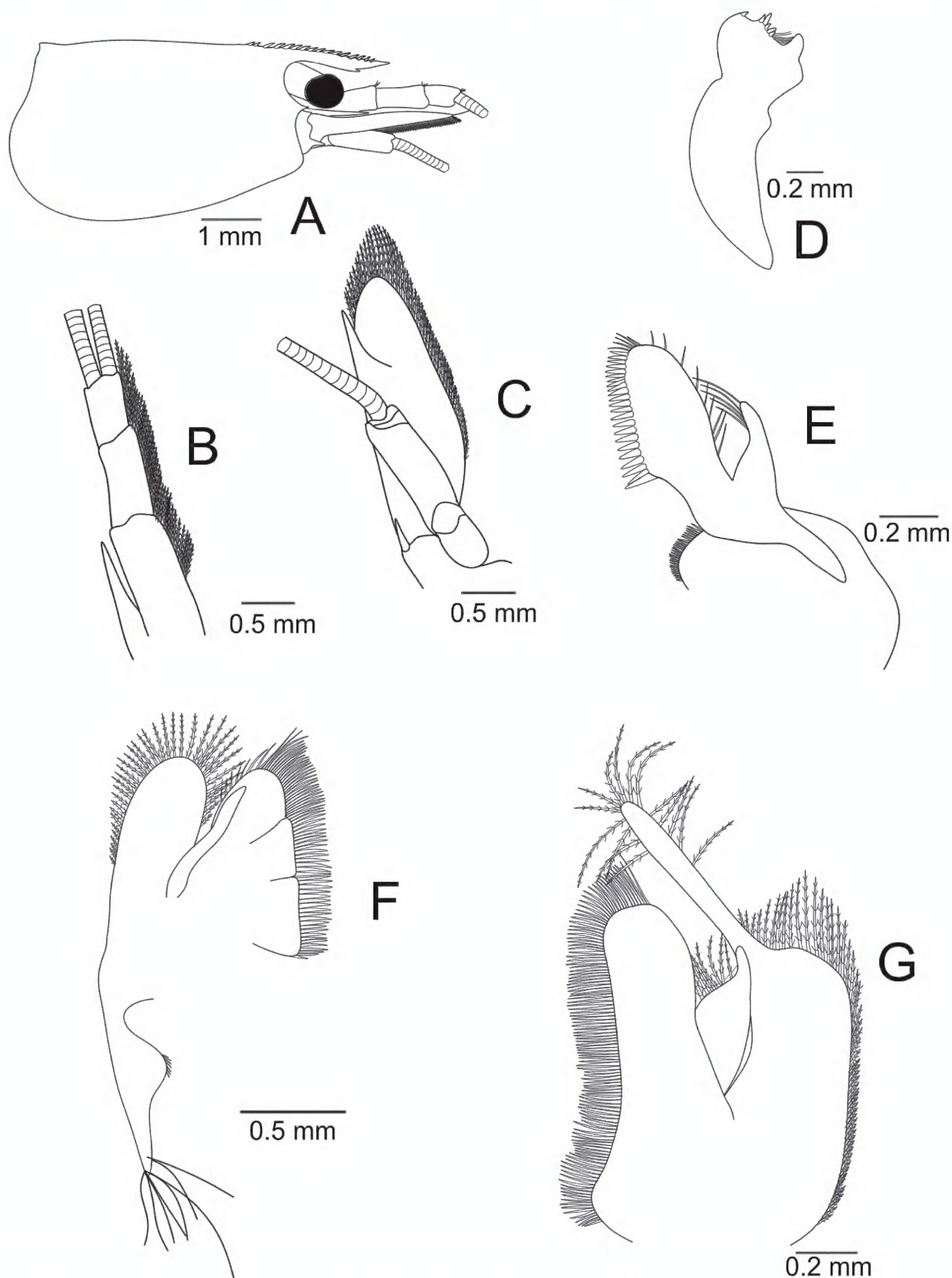


Figure 3. *Caridina clinata* Cai, Nguyen & Ng, 1999. A–G. Male (FU5725002): A. Cephalothorax; B. Antennular peduncle; C. Antenna; D. Mandible; E. Maxillula; F. Maxilla; G. First maxilliped.

from 0.6%–1.2% for COI and 0.7%–1.6% for 16S rRNA. *C. clinata* from Hainan Island and from Vietnam are closely related in the ML phylogenetic tree based on COI and 16S, and cluster well into a single clade (ML bootstrap values > 70). These low divergence values support

the identification of the Ledong populations as *C. clinata* (Fig. 21, Suppl. materials 1, 2).

Coloration. Body yellowish to gray and dark gray. There is one transverse black stripe which is irregularly broken at the lateral posterior margin of the carapace,

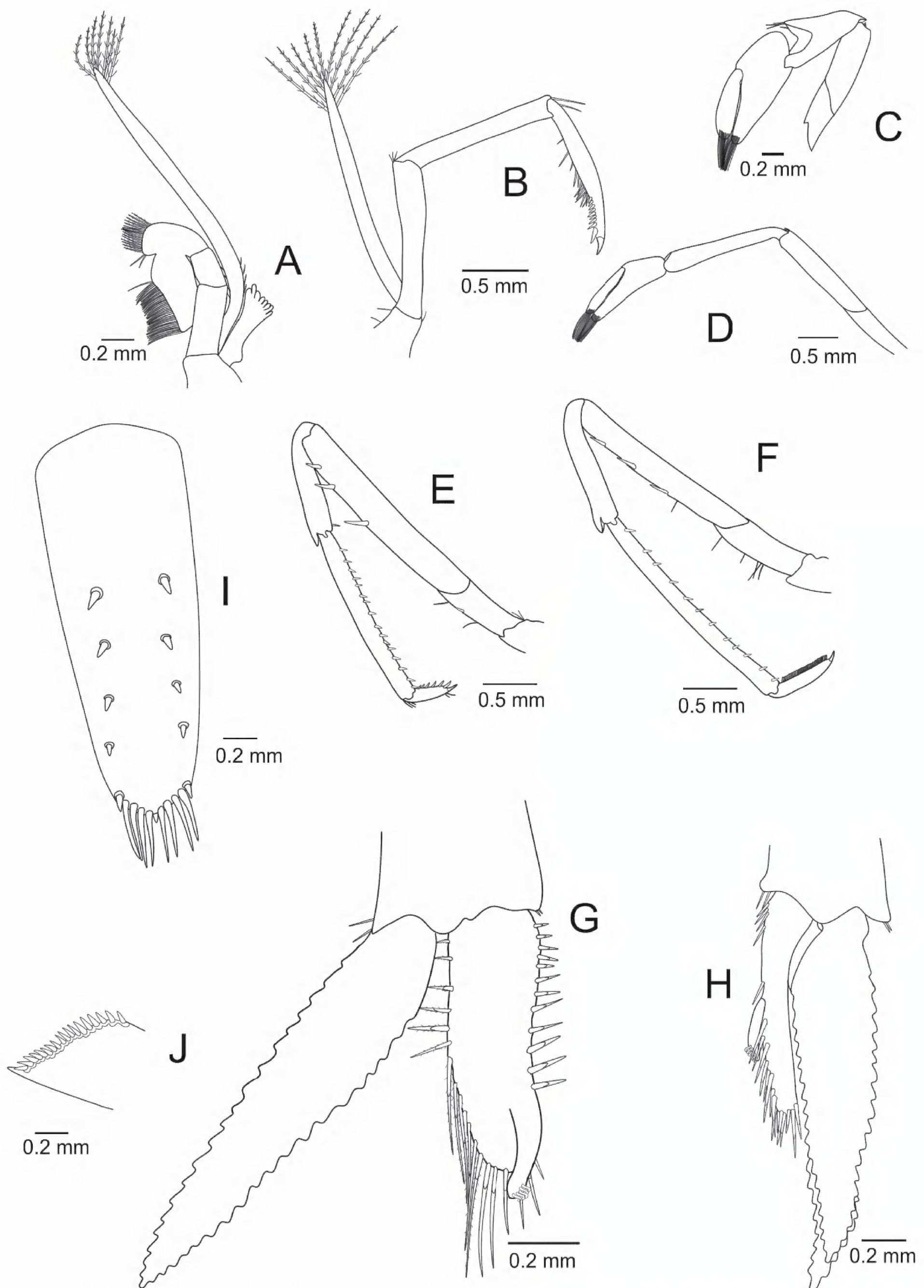


Figure 4. *Caridina clinata* Cai et al., 1999. A–F, H–J. Male (FU5725002); G. Male (FU5725004): A. Second maxilliped; B. Third maxilliped; C. First pereopod; D. Second pereopod; E. Third pereopod; F. Fifth pereopod; G. First pleopod of the male; H. Second pleopod of the male; I. Telson; J. Uropodal diaeresis.

some irregular black spots are present on the ventro-lateral parts of the carapace. The ventro-lateral portion of the abdominal tergal pleura is mottled with black spots adjacent to the articular knobs at the posterior bases of the pleura, black transverse stripes are present at the posteroventral ends of the first four pleura, the dorsum of the third abdominal somite has a black transverse stripe. The antenna, antennule and telson are yellowish to orange, the pereopods are translucent to yellowish (Fig. 2A).

Ecological notes. *C. clinata* was collected from site 1–3. At site 1, the stream measured 0.5–1.0 m in width and 0.5 m in depth, and its substrate consisted of rock, mud and aquatic plants. At site 2, the stream measured 0.2–0.3 m in width and 0.1 m in depth, and its substrate consisted of rock, gravel and mud. At site 3, the stream measured 0.3 m in width and 0.1 m in depth, and its substrate consisted of rock, mud and leaf litter. The shrimps live densely among leaf litter and marginal vegetation. The stream water was intermediately flowing (Fig. 2A, Table 1).

Distribution. Hainan Island, China and Vietnam.

***Caridina caii* Hou, Zhang & Guo, sp. nov.**

<https://zoobank.org/DDE0A667-A48F-44B1-A6BC-99ADCE80C748>

Figs 2B, 5, 6

Caridina clinata Cai, 2014: 207–231, Figs 10, 11.

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 4.3 mm, (FU5722001), Wuzhishan City, 18°54'15"N, 109°37'33"E, al. 643 m, stn. 4, coll. WANG C. Y. and HOU J. J., 28 Jan. 2024.

Paratypes: 1 ♂, cl 4.1 mm, (FU5722002); 1 ♂, cl 4.2 mm, (FU5722003); 1 ♂, cl 4.0 mm, (FU5722005); 1 ♀, cl 4.7 mm, (FU5722004); 1 ♀, cl 3.8 mm, (FU5722006); 2 ♀♀, cl 4.2–4.6 mm, (FU5722007); 1 ovigerous ♀, cl 4.9 mm, (FU5722008), same collection data as holotype.

Comparative material. *Caridina lanceifrons* Yu, 1936. CHINA – Hainan Island • 3 ♂♂, cl 3.8–4.9 mm, (FU5727023); 3 ♀♀, cl 5.2–6.1 mm, (FU5727024), Qiongzong County, 19°1'26"N, 109°50'27"E, al. 312 m, stn. 6, coll. WANG C Y and HOU J J, 23 Jan 2024. *Caridina minnanica* Liang, 2002. CHINA – Guangdong Prov. • 1 ♂, cl 3.1 mm, (FU5290001), Jiangmen City, coll. Wen, 28 Feb 2025. 2 ♀♀, cl 5.6–6.1 mm, (FU5166001), Shanwei City, coll. ZHU, 8 Jul. 2025.

Description. **Body** (Fig. 2B): Males up to 4.3 mm cl, females up to 4.9 mm cl. Sixth abdominal somite 0.49–0.55 times as long as carapace.

Rostrum (Fig. 5A): Short, reaching to the end of the second segment of antennular peduncle, sloping ventral anteriorly; 0.4–0.5 of cl; armed dorsally with 11–16 teeth, including 3–5 on carapace posterior to orbital margin, ventrally with 1–3 teeth; rostral formula 3–5+8–11/1–3; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 5A): Well-developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 5A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 5B): Stylocerite reaching 0.75–0.89 times as long as basal segment of antennular peduncle; basal segment shorter or as long as combined length of second and third segments, 1.61–1.92 times as long as second segment; second segment 1.16–1.31 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 5C): Scaphocerite 3.3 times as long as wide, outer margin straight, aetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 5G): Palp of first maxilliped broadly triangular, ending in finger-like projection.

Third maxilliped (Fig. 6B): Basal segment as long as penultimate segment; penultimate segment 1.01–1.11 times as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 4–5 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching beyond the middle of second segment, distal margin with long plumose setae.

First pereopod (Fig. 6C): Chela 2.01–2.29 times as long as high, 1.32–1.69 times length of carpus; movable finger 3.00–3.63 times as long as wide and 0.96–1.33 times as long as palm, setal brushes well-developed; carpus 1.37–1.73 times as long as wide, slightly excavated distally; merus 0.91–1.29 times as long as carpus.

Second pereopod (Fig. 6D): Chela 2.68–2.95 times as long as high, 0.86–0.88 times as long as carpus; movable finger 3.62–4.10 times as long as wide and 1.47–1.93 times as long as palm, setal brushes well-developed; carpus 4.30–4.44 times as long as wide, slightly excavated distally; merus 0.91–1.01 times as long as carpus.

Third pereopod (Fig. 6E): Dactylus 3.21–4.28 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 5 spiniform setae; propodus 3.60–4.28 times as long as dactylus, 9.06–11.12 times as long as wide; carpus 0.65–0.69 times as long as propodus; merus 1.87–2.07 times as long as carpus, with 4 spiniform setae on the posterior margin. Ischium sometimes with 1 small movable spiniform setae on the posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

Fifth pereopod (Fig. 6F): Dactylus 3.10–4.28 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 25–29 spiniform setae; propodus 3.82–4.94 times as long as dactylus, 11.22–13.56 times as long as wide; carpus 0.53–0.55 times as long as propodus; merus 1.53–1.57 times as long as carpus, with 3–4 spiniform setae on the posterior margin.

First four pereopods with epipod.

First pleopod (Fig. 6G, H): Endopod of male first pleopod subtriangular, 0.34–0.38 times as long as exo-

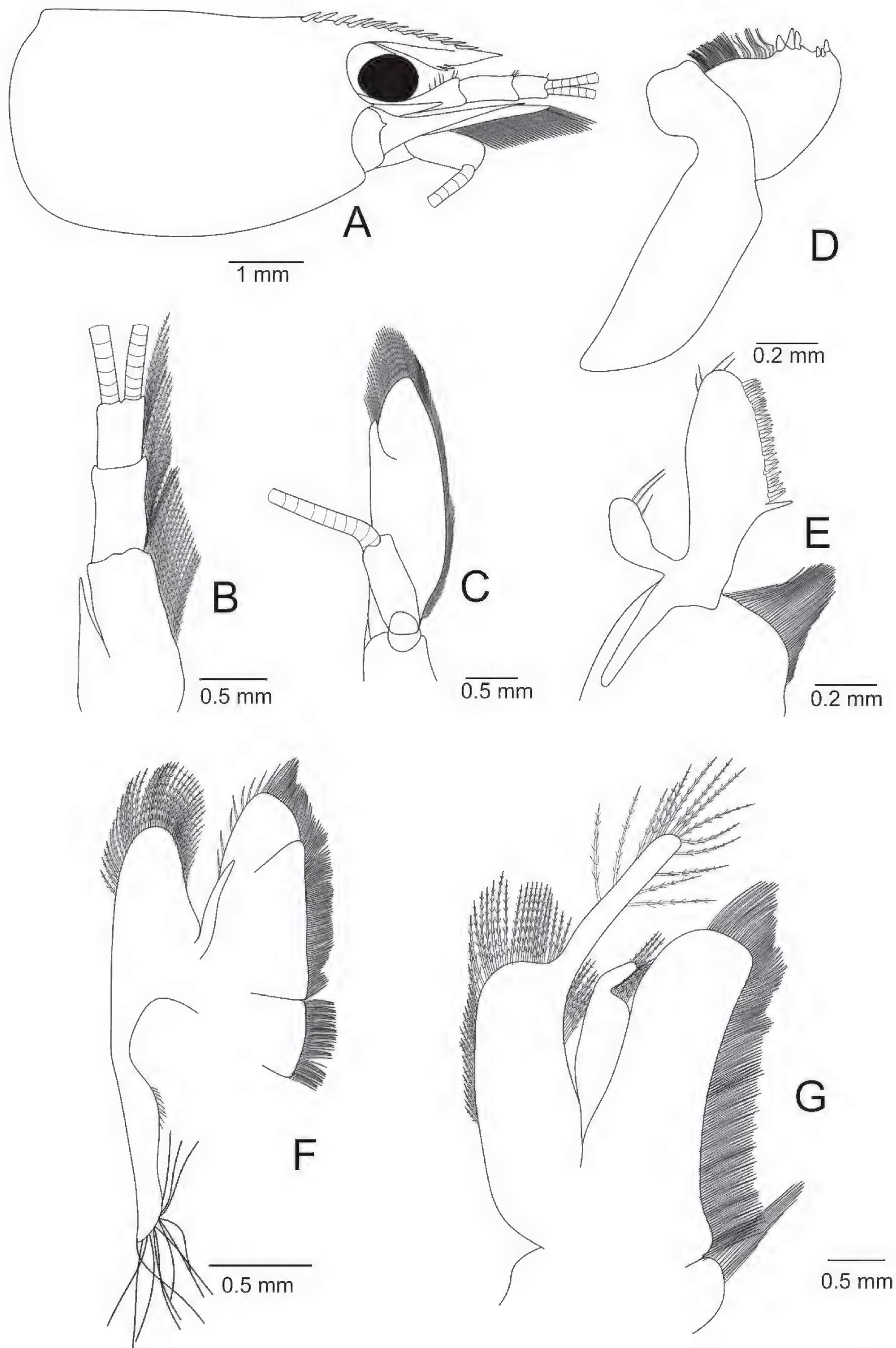


Figure 5. *Caridina caii* Hou, Zhang & Guo, sp. nov. **A.** Holotype male (FU5727001); **B–G.** Paratype male (FU5722002): **A.** Cephalothorax; **B.** Antennular; **C.** Antenna; **D.** Mandible; **E.** Maxillula; **F.** Maxilla; **G.** First maxilliped.

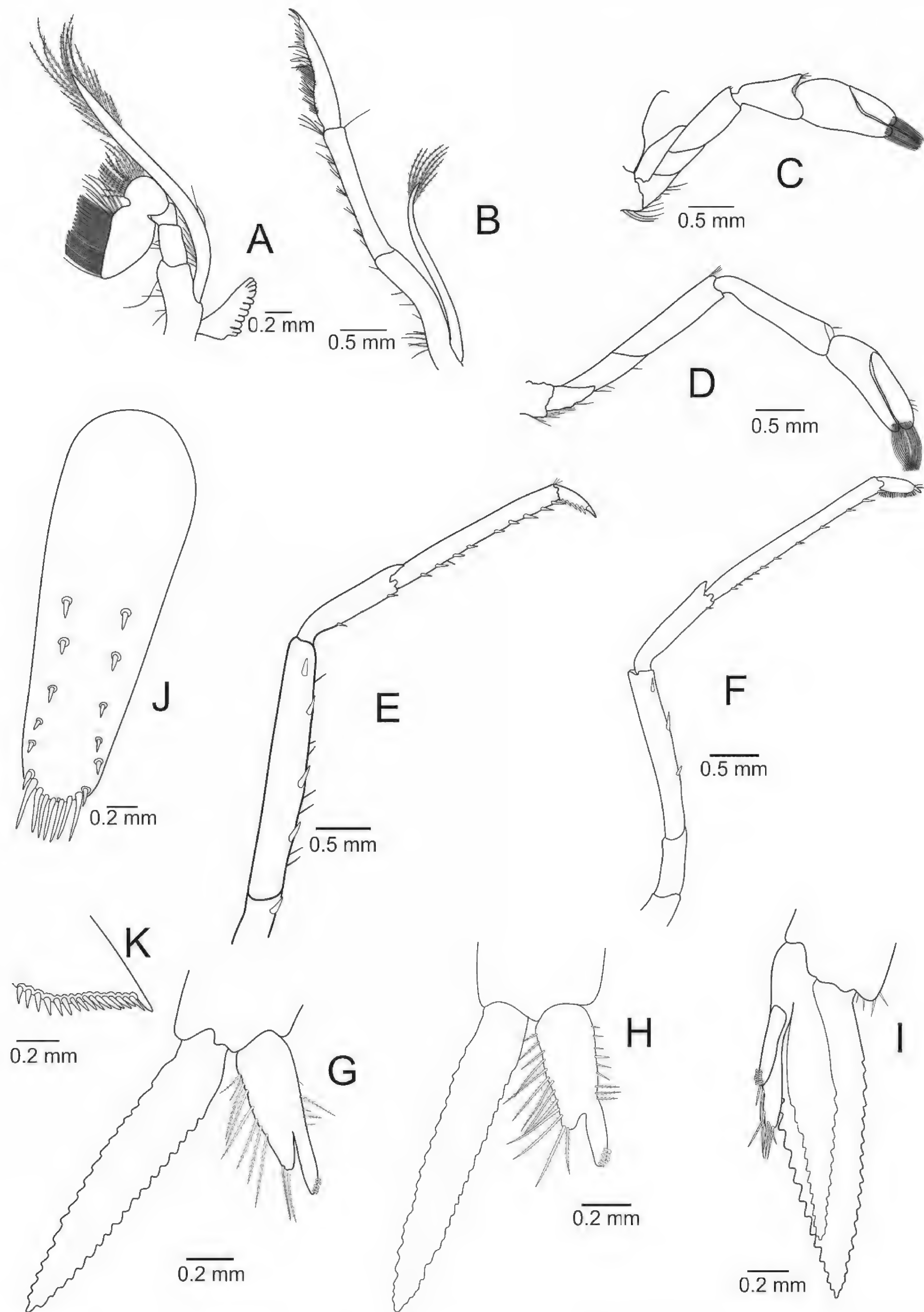


Figure 6. *Caridina caii* Hou, Zhang & Guo, sp. nov. **A–G, I–K.** Paratype male (FU5722002); **H.** Paratype male (FU5722004): **A.** Second maxilliped; **B.** Third maxilliped; **C.** First pereopod; **D.** Second pereopod; **E.** Third pereopod; **F.** Fifth pereopod; **G, H.** First pleopod of the male; **I.** Second pleopod of the male; **J.** Telson; **K.** Uropodal diaeresis.

pod, 2.27–2.44 times as long as wide; appendix interna well developed, arising from distal 0.33 of endopod, reaching slightly beyond the end of endopod, distally with cincinuli.

Second pleopod (Fig. 6I): Appendix masculina club-shaped, reaching 0.57–0.64 length of exopod, inner margin and tip bearing nearly equal long and stout spiniform setae; appendix interna well developed, reaching 0.25 length of appendix masculina, distally with cincinuli.

Telson (Fig. 6J): Tapering posterior, with a projection, with 5 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin with 4 pairs of intermedial spiniform setae. Exopodite of the uropod (Fig. 6K) bears a series of 16–18 movable spinules along diarsis.

Eggs: 0.57–0.62 mm × 0.98–1.02 mm in diameter.

Remarks. Based on morphological and molecular analyses of specimens from Wuzhishan (the same locality studied by Cai) compared with topotype specimens of *Caridina clinata* from Vietnam, our findings reveal distinct differences between the Wuzhishan population and *C. clinata*, demonstrating that its initial identification as *C. clinata* by Cai (2014) was incorrect. The Wuzhishan population represents a new species, formally described as *Caridina caii* sp. nov. It can be distinguished from *C. clinata* by the following key features: the different shape and proportion of the endopod of the male first pleopod (subtriangular with pointed tip, 0.34–0.38 times as long as exopod, 2.27–2.44 times as long as wide vs. oblong-reniform with rounded tip, 0.46–0.67 times as long as exopod, 2.40–3.04 times as long as wide in *C. clinata*); the broader carpus of second pereopod (carpus 4.30–4.44 times as long as wide vs. carpus 4.70–6.30 times in *C. clinata*); fewer spiniform setae on the flexor margin of the dactylus of the fifth pereopod (25–29 spiniform setae vs. 41–51 spiniform setae in *C. clinata*); and smaller eggs (0.57–0.62 × 0.98–1.02 mm vs. 0.60–0.75 × 1.10–1.15 mm in *C. clinata*).

At first glance, *Caridina caii* sp. nov. closely resembles *C. minnanica* Liang, 2002. However, it can be differentiated from the latter by the shorter rostrum (reaching only to the end of the second segment of the antennular peduncle vs. to the end of the antennular peduncle in *C. minnanica*) and with fewer ventral teeth (1–3 teeth vs. 4–8 teeth in *C. minnanica*); the palp of the first maxilliped with a long finger-like projection (vs. absent in *C. minnanica*); and the shorter carpus of the second pereopod (4.30–4.44 times as long as wide vs. 5.60–6.20 times in *C. minnanica*).

Cai (2014) noted that the Wuzhishan population morphologically resembles *Caridina lanceifrons* and provided an in-depth comparison between these two taxa. Our study supports Cai's conclusion that *C. caii* sp. nov. is morphologically distinct from *C. lanceifrons*. Our phylogeny suggests that *C. caii* sp. nov. clusters with *C. lanceifrons* but is not closely related to *C. clinata*.

Molecular results. The intraspecific p-distances of COI of the new species were 0.6%–2.5%. The new species is most similar in genetic divergence (p-distance) to

C. lanceifrons (4.0%–6.7%) and *C. minnanica* (7.5%–9.6%). According to molecular analysis, the distance between the new species and *C. clinata* is 25.4%–29.3%. The intraspecific p-distances of 16SrRNA of the new species were 0%–0.9%. The new species is most similar in genetic divergence (p-distance) to *C. lanceifrons* (2.0%–3.1%) and *C. minnanica* (2.5%–3.6%). According to molecular analysis, the distance between the new species and *C. clinata* is 10.8%–12.1% (Fig. 21, Suppl. materials 1, 2).

Coloration. When alive, the body of shrimp dense with many gray small pigment dots (Fig. 2B).

Etymology. *Caridina caii* is dedicated to Cai Y. X., who not only discovered the species but also made outstanding contributions to carcinology.

Ecological notes. *C. caii* sp. nov. was collected from site 4. At site 4, the stream measured 1.0–2.0 m in width and 0.5–1.0 m in depth, and its substrate consisted of gravel, sand, and leaf litter. The shrimps lived densely among leaf litter, exhibiting high population density. The stream water was Intermediately flowing (Fig. 2B, Table 1).

Distribution. Only occurring in Wuzhishan City, Hainan Island.

Caridina wenchangensis Hou, Zhang & Guo, sp. nov.

<https://zoobank.org/4A37F24E-167C-4FB2-8684-6F190468EE72>

Figs 2C, 7, 8

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 3.4 mm, (FU5713001), Wenchang City, 19°26'43"N, 110°34'39"E, al. 72 m, stn. 5, coll. WANG C. Y. and HOU J. J., 22 Jan. 2024.

Paratypes: 1 ♂, cl 2.6 mm, (FU5713002); 1 ♂, cl 2.7 mm, (FU5713003); 2 ♂♂, cl 2.7–2.9 mm, (FU5713005); 1 ♀, cl 3.1 mm, (FU5713004); 1 ovigerous ♀, cl 3.4 mm, (FU5713006), same collection data as holotype.

Comparative material. *Caridina clinata* Cai, Nguyen & Ng, 1999. See this article. *Caridina haivanensis* Do & Dang, 2010. VIETNAM – Da Nang Prov. • 1 ♂, cl 4.4 mm, (FU55001); 1 ♂, cl 5.0 mm, (FU55002); 1 ♂, cl 4.2 mm, (FU55003); 2 ♂♂, cl 4.2–4.4, (FU55004); 1 ♀, cl 4.5 mm, (FU55005); 1 ♀, cl 5.3 mm, (FU55006); 1 ♀, cl 5.3 mm, (FU55007); 6 ♀♀, cl 4.1–5.2 mm, (FU55008), Tho Quang, 16°6'46"N, 108°15'25"E, al. 26 m, stn. 14, coll. HAN Z. K., 10 Jul. 2025.

Description. **Body** (Fig. 2C): Small, slender and sub-cylindrical, males up to 3.4 mm cl, females up to 3.4 mm cl. Sixth abdominal somite 0.41–0.48 times as long as carapace.

Rostrum (Fig. 7A): Short, reaching to the end of the first segment to the middle of the second segment of antennular peduncle, sloping ventral anteriorly; 0.3–0.5 of cl; armed dorsally with 12–15 teeth, including 3–5 on carapace posterior to orbital margin, ventrally with 2–4 teeth; rostral formula 3–5+9–10/2–4; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

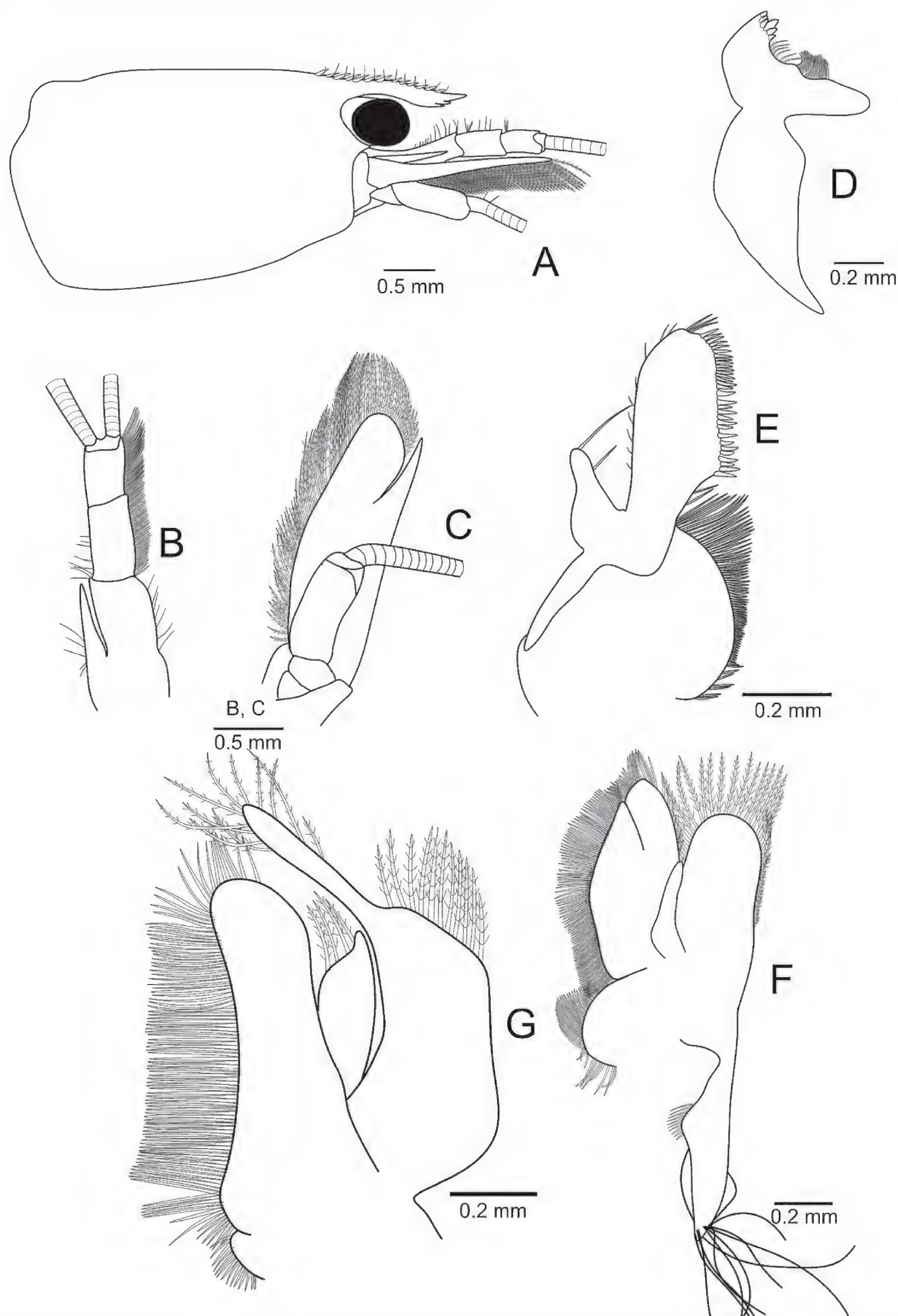


Figure 7. *Caridina wenchangensis* Hou, Zhang & Guo, sp. nov. **A.** Holotype male (FU5713001); **B–G.** Paratype male (FU5713003): **A.** Cephalothorax; **B.** Antennular; **C.** Antenna; **D.** Mandible; **E.** Maxillula; **F.** Maxilla; **G.** First maxilliped.

Eyes (Fig. 7A): Well-developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 7A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 7B): Peduncle reaching slightly short of scaphocerite; stylocerite reaching 0.86–0.96 times as long as basal segment of antennular peduncle; basal segment shorter or as long as combined length of second and third segments, 1.72–1.96 times as long as second segment; second segment 1.00–1.10 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 7C): Scaphocerite 3.0–3.2 times as long as wide, outer margin straight, asetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 7G): Palp of first maxilliped broadly triangular, ending in a finger-like projection.

Third maxilliped (Fig. 8B): Basal segment 0.91–1.10 times as long as penultimate segment; penultimate segment as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 3–5 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching beyond the middle of second segment, distal margin with long plumose setae.

First pereopod (Fig. 8C): Chela 1.90–2.26 times as long as high, 1.21–1.55 times as long as carpus; movable finger 2.55–3.45 times as long as wide and 0.86–1.10 times as long as palm, setal brushes well developed; carpus 1.49–1.94 times as long as wide, slightly excavated distally; merus 0.95–1.16 times as long as carpus.

Second pereopod (Fig. 8D): Chela 2.30–2.70 times as long as high, 0.75–0.80 times as long as carpus; movable finger 3.50–3.81 times as long as wide and 1.24–1.53 times as long as palm, setal brushes well-developed; carpus 4.59–5.41 times as long as wide, slightly excavated distally; merus 0.74–1.00 times as long as carpus.

Third pereopod (Fig. 8E): Dactylus 3.36–3.90 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 5 spiniform setae; propodus 3.27–3.83 times as long as dactylus, 8.65–9.43 times as long as wide; carpus 0.60–0.69 times as long as propodus; merus 1.80–2.29 times as long as carpus, with 3–4 spiniform setae on the posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

Fifth pereopod (Fig. 8F): Dactylus 3.13–4.24 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 29–31 spiniform setae; propodus 3.30–4.24 times as long as dactylus, 9.16–11.29 times as long as wide; carpus 0.54–0.58 times as long as propodus; merus 1.42–1.61 times as long as carpus, with 3 spiniform setae on the posterior margin.

First four pereopods with epipod.

First pleopod (Fig. 8G): Endopod in male 0.49–0.51 times as long as exopod, oblong-reniform, 2.72–3.34

times as long as distally wide, tip rounded, inner margin concave, bearing nearly equal short spine setae, outer margin slightly convex, long pappose setae on outer and distal margins, medium-length setae on inner margin; appendix interna well developed, arising from distal 0.33 of endopod, reaching slightly beyond end of endopod, distally with cincinuli.

Second pleopod (Fig. 8H): Appendix masculina rod-shaped, reaching 0.69–0.71 length of exopod, some short spiniform setae on basal part, and inner margin and tip bearing nearly equal long and stout spiniform setae; appendix interna well-developed, reaching 0.55–0.57 length of appendix masculina, distally with cincinuli.

Telson (Fig. 8I): Tapering posterior, with a projection, with 4 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin with 4 pairs of intermedial spiniform setae, close in length. Exopodite of the uropod (Fig. 8J) bears a series of 14–18 movable spinules along diarsis.

Eggs: 0.58–0.60 mm × 0.92–0.98 mm in diameter. Females of this small-bodied species attain sexual maturity and carry eggs at approximately tl 11 mm.

Remarks. *Caridina wenchangensis* sp. nov., is quite similar to *C. clinata* in rostrum shape and indentation, the proportions between the joints of pereopods. However, it can be separated from *C. clinata* by the shorter appendix interna and the different shape appendix masculina of male second pleopod (appendix interna reaching 0.55–0.57 length of appendix masculina, appendix masculina is slightly wider in the middle and slightly narrower at the ends vs. appendix interna reaching 0.52–0.63 of appendix masculina, and appendix masculina is rod-shaped with uniform width in *C. clinata*); the fewer spiniform setae on flexor margin of dactylus of fifth pereopod (29–31 spiniform setae vs. 41–51 spiniform setae in *C. clinata*); the relatively broader scaphocerite (3.0–3.2 times as long as wide vs. 3.1–3.4 times in *C. clinata*); and slightly smaller eggs (0.58–0.60 × 0.92–0.98 mm vs. 0.60–0.75 × 1.10–1.15 mm in *C. clinata*).

Caridina wenchangensis sp. nov. indeed resembles *C. haivanensis* from its sexual appendages, shape of the telson, and the proportions between the joints of the first, third, and fifth pereopods. However, it can be separated from *C. haivanensis* by the more dorsal rostral teeth (12–15 teeth vs. 0–3 teeth in *C. haivanensis*); the relatively broader chela of second pereopod (2.30–2.70 times as long as wide vs. 3.07 times in *C. haivanensis*); fewer spiniform setae on the flexor margin of the dactylus of the fifth pereopod (29–31 spiniform setae vs. 30–42 spiniform setae in *C. haivanensis*); fewer spinules on the uropodal diarsis (14–18 spinules vs. 22–24 spinules in *C. haivanensis*); and the smaller eggs (0.58–0.60 × 0.92–0.98 mm vs. 0.75–0.80 × 1.10–1.30 mm).

Molecular results. The intraspecific p-distances of COI of the new species were 0%. The new species is most similar in genetic divergence (p-distance) to *C. tunchengensis* sp. nov. (9.1%–9.4%) and *C. clinata* (9.3%–9.6%). According to molecular analysis, the distance between the

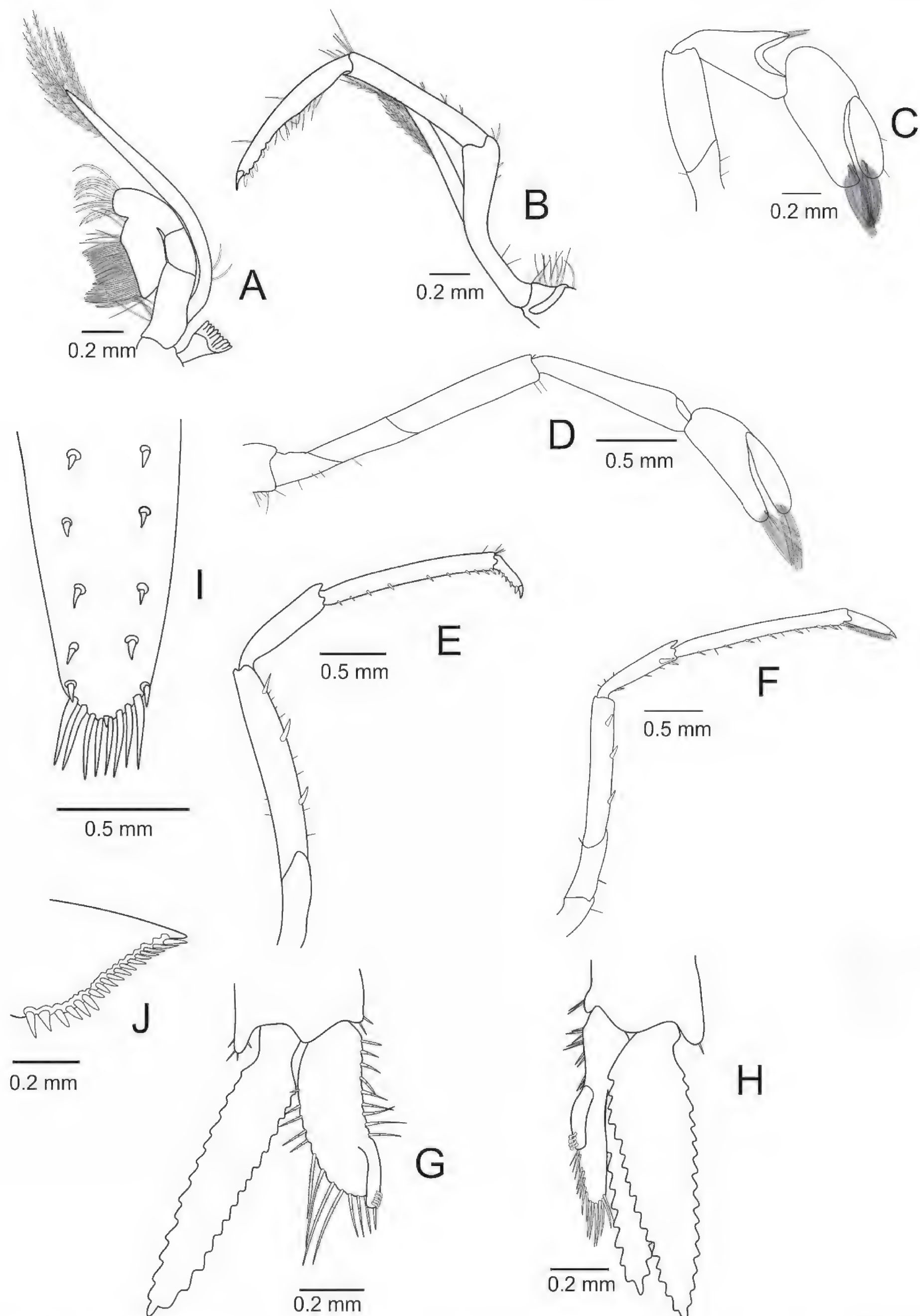


Figure 8. *Caridina wenchangensis* Hou, Zhang & Guo, sp. nov. **A–I.** Paratype male (FU5713003); **J.** Paratype male (FU5713002): **A.** Second maxilliped; **B.** Third maxilliped; **C.** First pereiopod; **D.** Second pereiopod; **E.** Third pereiopod; **F.** Fifth pereiopod; **G.** First pleopod of the male; **H.** Second pleopod of the male; **I.** Telson; **J.** Uropodal diaeresis.

new species and *C. haivanensis* is 10.6%. The intraspecific p-distances of 16SrRNA of the new species were 0%–0.7%. The new species is most similar in genetic divergence (p-distance) to *C. clinata* (3.7%–4.6%) and *C. huangi* sp. nov. (4.1%–4.8%). According to molecular analysis, the distance between the new species and *C. haivanensis* is 5.5%–6.3% (Fig. 21, Suppl. materials 1, 2).

Coloration. When alive, the female always black and brown with a texture like marble on body, some present a topline on the back. Some transverse black stripes and spots which are irregularly broken at five abdominal of male. (Fig. 2C).

Etymology. The new species is named after its type locality name: Wenchang City.

Ecological notes. *C. wenchangensis* sp. nov. was collected from site 5. At site 5, the stream measured 0.5–1.0 m in width and 0.2–0.3 m in depth, and its substrate consisted of gravel, mud, and leaf litter. The shrimps lived among leaf litter, exhibiting low population density. The stream water was slowly flowing (Fig. 2C, Table 1).

Distribution. Only occurring in Chongxing Town, Wenchang City, Hainan Island.

***Caridina qiongzongensis* Hou, Zhang & Guo, sp. nov.**

<https://zoobank.org/AC7E3B10-89E4-4A9F-A24E-1246D36B102F>

Figs 2D, 9, 10

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 3.7 mm, (FU5727015), Qiongzong County, 19°1'26"N, 109°50'27"E, al. 312 m, stn. 6, coll. WANG C. Y. and HOU J. J., 23 Jan. 2024.

Paratypes: 1 ♂, cl 3.5 mm, (FU5727016); 1 ♂, cl 4.2 mm, (FU5727017); 1 ♂, cl 4.0 mm, (FU5727020); 1 ovigerous ♀, cl 5.0 mm, (FU5727018); 1 ♀, cl 4.6 mm, (FU5727019), same collection data as holotype. 1 ♂, cl 4.6 mm, (FU5727021); 2 ♀♀, cl 4.4–5.0 mm, (FU5727022), Qiongzong County, 19°1'56"N, 109°47'26"E, al. 336 m, stn. 7, coll. YU W. D. and HOU J. J., 23 Jan. 2024.

Comparative material. *Caridina serrata* Stimpson, 1860. CHINA – Guangdong Prov. • 3 ♂♂, cl 3.2–3.8 mm, (FU5190001), Guishan Island, Zhuhai City, coll. Guo Z. L., 27 Nov. 2023.

Description. **Body** (Fig. 2D): Small, slender and sub-cylindrical, males up to 4.6 mm cl, females up to 5.0 mm cl. Sixth abdominal somite 0.45–0.52 times as long as carapace.

Rostrum (Fig. 9A, B): Short, straight, reaching to the end of the first segment to the middle of 2nd segment of antennular peduncle; 0.2–0.4 of cl; armed dorsally with 8–12 teeth, including 2–5 on carapace posterior to orbital margin, ventrally with 0–2 teeth; rostral formula 2–5+6–7/0–2; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 9A, B): Well-developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 9A, B): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygosto-

mian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 9C): Stylocerite reaching 1.05–1.26 times as long as basal segment of antennular peduncle; basal segment as long or shorter than combined length of second and third segments, 1.48–1.63 times as long as second segment; second segment 1.70–2.01 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 9D): Scaphocerite 3.7 times as long as wide, outer margin straight, asetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 9H): Palp of first maxilliped broadly triangular, ending in finger-like projection.

Third maxilliped (Fig. 10B): Basal segment 0.95–1.26 times as long as penultimate segment; penultimate segment 0.96–1.15 times as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 5–6 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching beyond the beginning of second segment, distal margin with long plumose setae.

First pereopod (Fig. 10C): Chela 2.06–2.25 times as long as high, 1.34–1.51 times as long as carpus; movable finger 2.58–3.32 times as long as wide and 0.87–1.16 times as long as palm, setal brushes well-developed; carpus 1.18–1.66 times as long as wide, slightly excavated distally; merus 0.95–1.44 times as long as carpus.

Second pereopod (Fig. 10D): Chela 2.38–2.90 times as long as high, 0.83–0.90 times as long as carpus; movable finger 3.54–4.51 times as long as wide and 1.13–1.53 times as long as palm, setal brushes well-developed; carpus 4.13–4.90 times as long as wide, slightly excavated distally; merus 0.95–1.12 times as long as carpus.

Third pereopod (Fig. 10E): Dactylus 2.88–4.03 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 5–6 spiniform setae; propodus 2.88–4.51 times as long as dactylus, 8.72–10.61 times as long as wide; carpus 0.61–0.87 times as long as propodus; merus 1.76–2.16 times as long as carpus, with 3–4 spiniform setae on the posterior margin. Ischium sometimes with 1 small movable spiniform setae on the posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

Fifth pereopod (Fig. 10F): Dactylus 3.22–4.70 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 35–52 spiniform setae; propodus 3.02–4.94 times as long as dactylus, 9.38–12.47 times as long as wide; carpus 0.43–0.67 times as long as propodus; merus 1.41–1.55 times as long as carpus, with 2–3 spiniform setae on the posterior margin. Ischium sometimes with 1 spine on the posterior margin.

First four pereopods with epipod.

First pleopod (Fig. 10G): Endopod in male 0.50–0.56 times as long as exopod, oblong-reniform, distal end is distinctly narrower than the basal part, 2.77–3.09 times as long as wide, tip rounded, inner margin slightly concave.

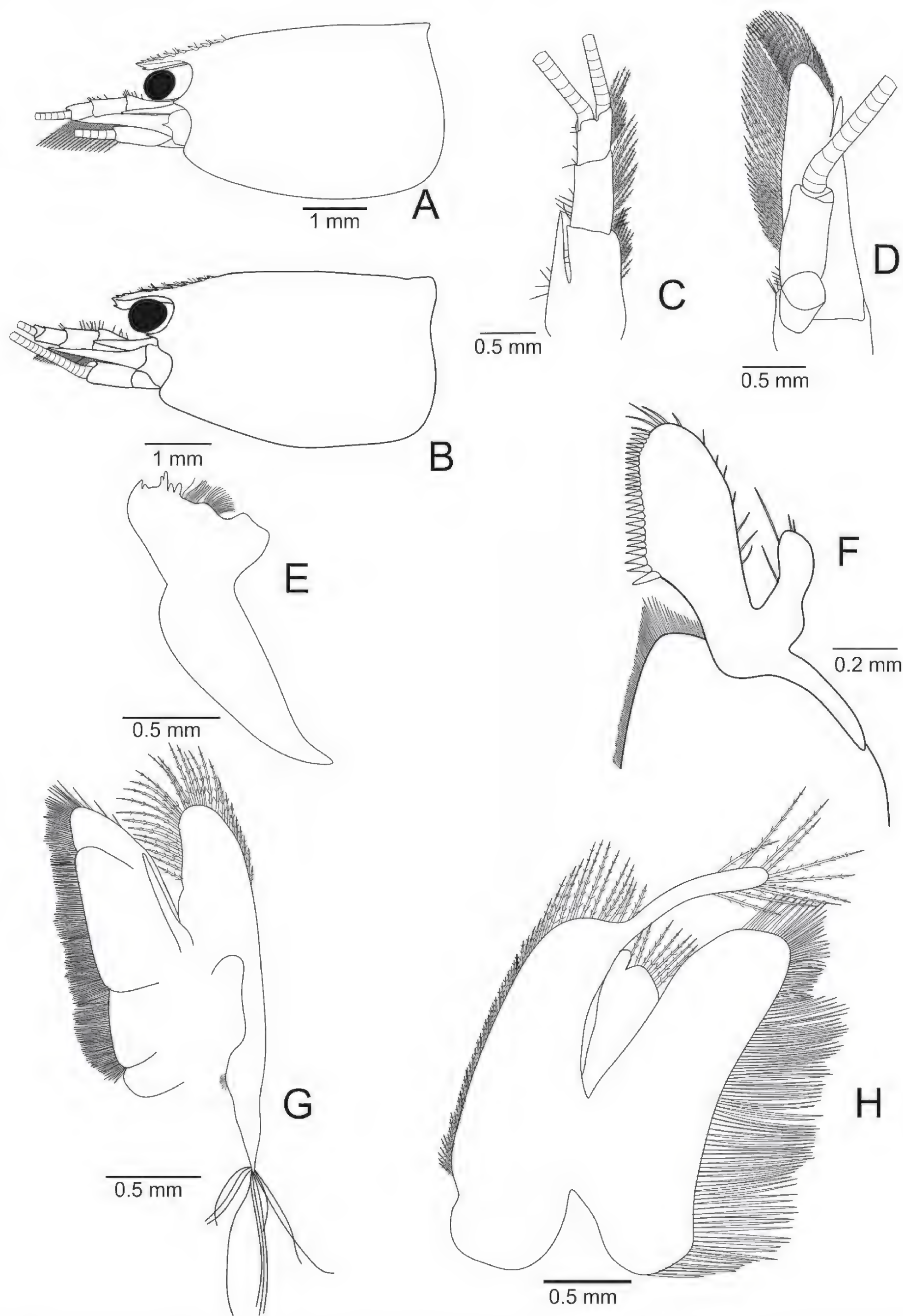


Figure 9. *Caridina qionghongensis* Hou, Zhang & Guo, sp. nov. **A.** Holotype male (FU5727015); **B–H.** Paratype male (FU5727021): **A, B.** Cephalothorax; **C.** Antennular; **D.** Antenna; **E.** Mandible; **F.** Maxillula; **G.** Maxilla; **H.** First maxilliped.

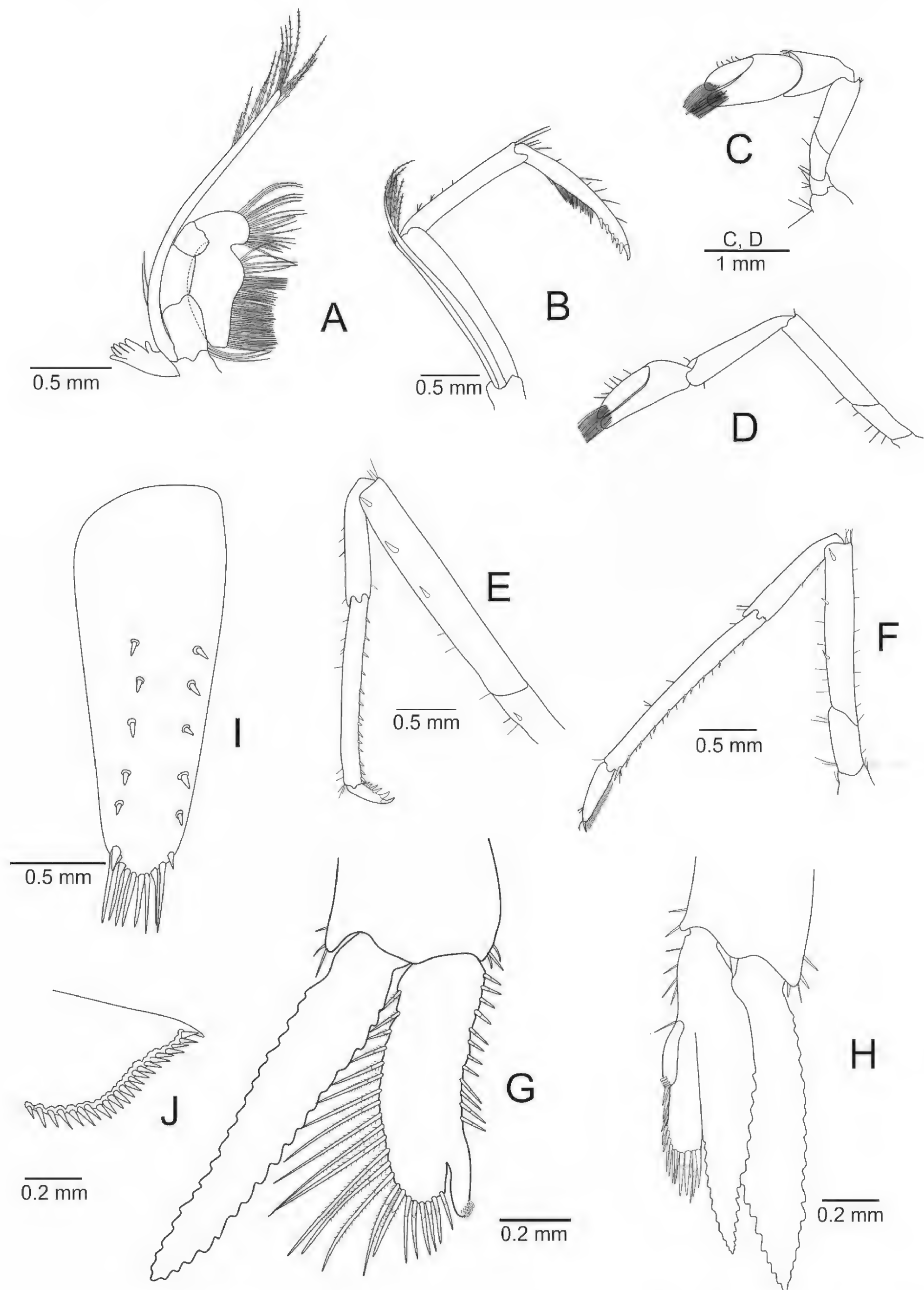


Figure 10. *Caridina qionghongensis* Hou, Zhang & Guo, sp. nov. A–J. Paratype male (FU5727021): A. Second maxilliped; B. Third maxilliped; C. First pereopod; D. Second pereopod; E. Third pereopod; F. Fifth pereopod; G. First pleopod of the male; H. Second pleopod of the male; I. Telson; J. Uropodal diaeresis.

Outer margin slightly convex, long pappose setae on outer and distal margins, medium-length setae on inner margin; appendix interna well developed, arising from distal 0.25–0.33 of endopod, reaching slightly beyond end of endopod, distally with cincinuli.

Second pleopod (Fig. 10H): Appendix masculina rod-shaped, wider and slightly swollen in the end, reaching 0.68–0.69 length of exopod, some short spiny setae on basal part, the spiniform setae at the end of appendix masculina are thicker, and the spiniform setae of middle of appendix masculina are shorter; appendix interna well developed, reaching 0.50–0.56 of appendix masculina, distally with cincinuli.

Telson (Fig. 10I): With 5 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin with 4 pairs of intermedial spiniform setae, the innermost one usually strongest and longest. Exopodite of the uropod (Fig. 10I) bears a series of 20–23 movable spinules along diarsis.

Eggs: 0.70–0.76 mm × 1.17–1.30 mm in diameter.

Remarks. Regarding the long stylocerite, the form of the telson, as well as the form and armature of the rostrum, *Caridina qionghongensis* sp. nov. is most similar to *C. serrata* Stimpson, 1860, a species widely distributed along the coastal areas and islands of Guangdong. It can be easily separated from *C. serrata* by the slender endopod of the male first pleopod (endopod 2.77–3.09 times as long as wide vs. 2.5 times in *C. serrata*); the shape and the spines of appendix masculina of the second pleopod (appendix masculina rod-shaped with slightly swollen tip, the long spiniform setae on the tip and the slightly shorter spiniform setae along the proximal inner margin vs. rod-shaped with slightly swollen midportion, equally stout spiniform setae along the inner margin and tip in *C. serrata*); slightly bigger eggs (0.70–0.76 × 1.17–1.30 mm vs. 0.56–0.62 × 0.90–0.96 mm in *C. serrata*).

Caridina qionghongensis sp. nov. is most similar to *C. clinata* Cai et al., 1999, in shape of sexual appendages and the proportions between the joints of pereopods. However, it can be separated from *C. clinata* by the fewer rostral teeth (dorsally with 8–12 teeth and ventrally with 0–2 teeth vs. dorsally with 12–21 teeth and ventrally with 1–5 teeth in *C. clinata*); the longer stylocerite (beyond of basal antennular segment vs. not reaching basal antennular segment in *C. clinata*); the slender scaphocerite (3.7 times as long as wide vs. 3.1–3.4 times in *C. clinata*); more spinules on the uropodal diarsis (20–23 spinules vs. 14–21 spinules in *C. clinata*); and slightly bigger eggs (0.70–0.76 × 1.17–1.30 mm vs. 0.60–0.75 × 1.10–1.15 mm in *C. clinata*).

Caridina qionghongensis sp. nov. is morphologically similar to *C. huangi* sp. nov. in the form and armature of the rostrum, the long stylocerite, and the proportions between the joints of pereopods. However, it can be separated by the slender endopod of the male first pleopod (2.77–3.09 times as long as wide vs. 2.40–2.82 times in *C. huangi* sp. nov.); the shape and the spines of appendix masculina of the second pleopod (appendix masculina rod-shaped with

slightly swollen tip, the long spiniform setae on the tip and the slightly shorter spiniform setae along the proximal inner margin vs. cylindrical with uniform width, two rows of equally stout spiniform setae along the inner margin and tip in *C. huangi* sp. nov.); the posterior of the telson lacks a projection (vs. a projection present in *C. huangi* sp. nov.); and slightly bigger eggs (0.70–0.76 × 1.17–1.30 mm vs. 0.66–0.85 × 1.10–1.27 mm in *C. huangi* sp. nov.).

Molecular results. The intraspecific p-distances of COI of the new species were 0%–0.6%. The new species is most similar in genetic divergence (p-distance) to *C. huangi* sp. nov. (6.8%–8.0%) and *C. brevilineata* sp. nov. (7.3%–7.5%). According to molecular analysis, the distance between the new species and *C. clinata* is 13.5%–14.5%. The intraspecific p-distances of 16S rRNA of the new species were 0%–0.7%. The new species is most similar in genetic divergence (p-distance) to *C. hepingensis* sp. nov. (1.6%–1.8%) and *C. huangi* sp. nov. (2.2%–2.5%). According to molecular analysis, the distance between the new species and *C. clinata* is 3.9%–5.0% (Fig. 21, Suppl. materials 1, 2).

Etymology. The new species is named after its type locality name: Qionghong County.

Coloration. Body translucent. Middle part of the plastron with a row of fine dark brown spots. Plastron margin with 4 slender vertical dark brown stripes; stripes in some individuals appear red. Middle part of the 6th abdominal segment with 1 blue patch. (Fig. 2D).

Ecological notes. *C. qionghongensis* sp. nov. was collected from site 6–7. At site 6, the stream measured 0.5 m in width and 0.2 m in depth, and its substrate consisted of rock, sand, and leaf litter. At site 7, the stream measured 2.0 m in width and 0.4 m in depth, and its substrate consisted of big rocks, gravel, and mud. The shrimps lived densely among leaf litter, exhibiting high population density. The stream water was intermediately flowing (Fig. 2D, Table 1).

Distribution. Only occurring in Yinggen Town, Qionghong County, Hainan Island.

Caridina huangi Hou, Zhang & Guo, sp. nov.

<https://zoobank.org/EAA58278-74B1-43C3-B9F6-558D17B28C0B>

Figs 2E, 11, 12

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 4.1 mm, (FU5727001), Qionghong County, 18°56'39"N, 109°57'1"E, al. 242 m, stn. 8, coll. WANG A. and HOU J. J., 17 Jan. 2024.

Paratypes. 1 ♂, cl 4.2 mm, (FU5727002); 1 ♂, cl 4.4 mm, (FU5727003); 1 ♂, cl 4.4 mm, (FU5727004); 2 ♂♂, cl 4.1–4.7 mm, (FU5727007); 1 ♀, cl 4.5 mm, (FU5727005); 1 ovigerous ♀, cl 4.6 mm, (FU5727006), same collection data as holotype.

Description. **Body** (Fig. 2E): Small, slender and sub-cylindrical, males up to 4.7 mm cl, females up to 4.6 mm cl. Sixth abdominal somite 0.46–0.52 times as long as carapace.

Rostrum (Fig. 11A): Short, straight, reaching to the end of the first segment to the middle of the second segment of antennular peduncle; 0.2–0.5 of cl; armed dorsally with 9–15 teeth, including 3–5 on carapace posterior to orbital margin, ventrally with 0–2 teeth; rostral formula 3–5+6–10/0–2; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 11A): Well-developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 11A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 11B): Stylocerite reaching 1.19–1.31 times as long as basal segment of antennular peduncle; basal segment shorter than combined length of second and third segments, 1.32–1.53 times as long as second segment; second segment 1.20–1.45 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 11C): Scaphocerite 3.0–3.3 times as long as wide, outer margin straight, asetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 11G): Palp of first maxilliped broadly triangular, ending in finger-like projection.

Third maxilliped (Fig. 12B): Basal segment 0.94–1.21 times as long as penultimate segment; penultimate segment 0.92–1.00 times as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 5–6 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching beyond the middle of second segment, distal margin with long plumose setae.

First pereopod (Fig. 12C): Chela 2.00–2.33 times as long as high, 1.30–1.44 times as long as carpus; movable finger 2.41–3.00 times as long as wide and 0.80–1.21 times as long as palm, setal brushes well developed; carpus 1.51–2.40 times as long as wide, slightly excavated distally; merus 1.03–1.21 times as long as carpus.

Second pereopod (Fig. 12D): Chela 2.44–2.92 times as long as high, 0.75–0.86 times as long as carpus; movable finger 3.87–4.79 times as long as wide and 1.10–1.54 times as long as palm, setal brushes well-developed; carpus 4.78–5.45 times as long as wide, slightly excavated distally; merus 0.79–1.03 times as long as carpus.

Third pereopod (Fig. 12E): Dactylus 3.22–3.81 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 4–6 spiniform setae; propodus 3.29–4.44 times as long as dactylus, 8.32–10.25 times as long as wide; carpus 0.58–0.79 times as long as propodus; merus 1.79–2.25 times as long as carpus, with 3 spiniform setae on posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

Fifth pereopod (Fig. 12F): Dactylus 3.27–4.85 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 41–49 spiniform setae; propodus 3.35–3.62 times as long

as dactylus, 11.22–13.12 times as long as wide; carpus 0.48–0.73 times as long as propodus; merus 1.48–1.86 times as long as carpus, with 2–3 spiniform setae on the posterior margin.

First four pereopods with epipod.

First pleopod (Fig. 12G): Endopod in male 0.44–0.46 times as long as exopod, oblong-reniform, 2.40–2.80 times as long as distally wide, tip rounded, inner margin slight concave, outer margin slightly convex, long pappose setae on outer and distal margins, medium-length setae on inner margin; appendix interna well-developed, arising from distal 0.33 of endopod, reaching slightly beyond end of endopod, distally with cincinuli.

Second pleopod (Fig. 12H): Appendix masculina rod-shaped, reaching 0.59–0.67 times length of exopod, some short spiniform setae on basal part, and inner margin and tip bearing nearly equal long and stout spiniform setae; appendix interna well developed, reaching 0.49–0.55 length of appendix masculina, distally with cincinuli.

Telson (Fig. 12I): Tapering posterior, with a projection, with 5 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin with 4 pairs of intermedial spiniform setae. Exopodite of the uropod (Fig. 12J) bears a series of 19–26 movable spinules along diaeresis.

Eggs: 0.66–0.85 mm × 1.10–1.27 mm in diameter.

Remarks. *Caridina huangi* sp. nov. resembles *C. pacbo* Do, von Rintelen & Dang, 2020 (distributed in Cao Bang Province, Vietnam) in the form and armature of the rostrum, the long stylocerite, the proportions between the joints of pereopods, and also in the coloration and pattern. However, the new species can be distinguished from *C. pacbo* by the slender scaphocerite (3.0–3.3 times as long as wide vs. 2.64–3.13 times in *C. pacbo*); more spinules on the uropodal diaeresis (19–26 spinules vs. 19–20 in *C. pacbo*); the slightly broader endopod of the first male pleopod (2.40–2.80 times as long as wide vs. 2.90–3.30 in *C. pacbo*); The long spiniform setae on the distal surface are more dense on the appendix masculina of male second pleopod (The long spiniform setae on the distal surface are more sparse on the appendix masculina of male second pleopod in *C. pacbo*).

Caridina huangi sp. nov. is most similar to *C. mongziensis* Liang, Yan & Wang, 1987 (distributed in Mongzi, Yunnan Province) in the shape of the sexual appendages and telson, the long stylocerite, and the proportions between the joints of the pereopods, although no material of *C. mongziensis* was available for the molecular phylogenetic analysis in this study. This new species can be easily distinguished from *C. mongziensis* by the slender scaphocerite (3.0–3.3 times as long as wide vs. 2.9–3.0 times in *C. mongziensis*); the slender propodus of the fifth pereopod (11.22–13.12 times as long as wide vs. 9.8 times in *C. mongziensis*) and more spiniform setae on the flexor margin of the dactylus (41–49 spiniform setae vs. 35–40 spiniform setae in *C. mongziensis*); the more spinules on the uropodal diaeresis (19–26 spinules vs. 13–18 in *C. mongziensis*); and the small eggs (0.66–

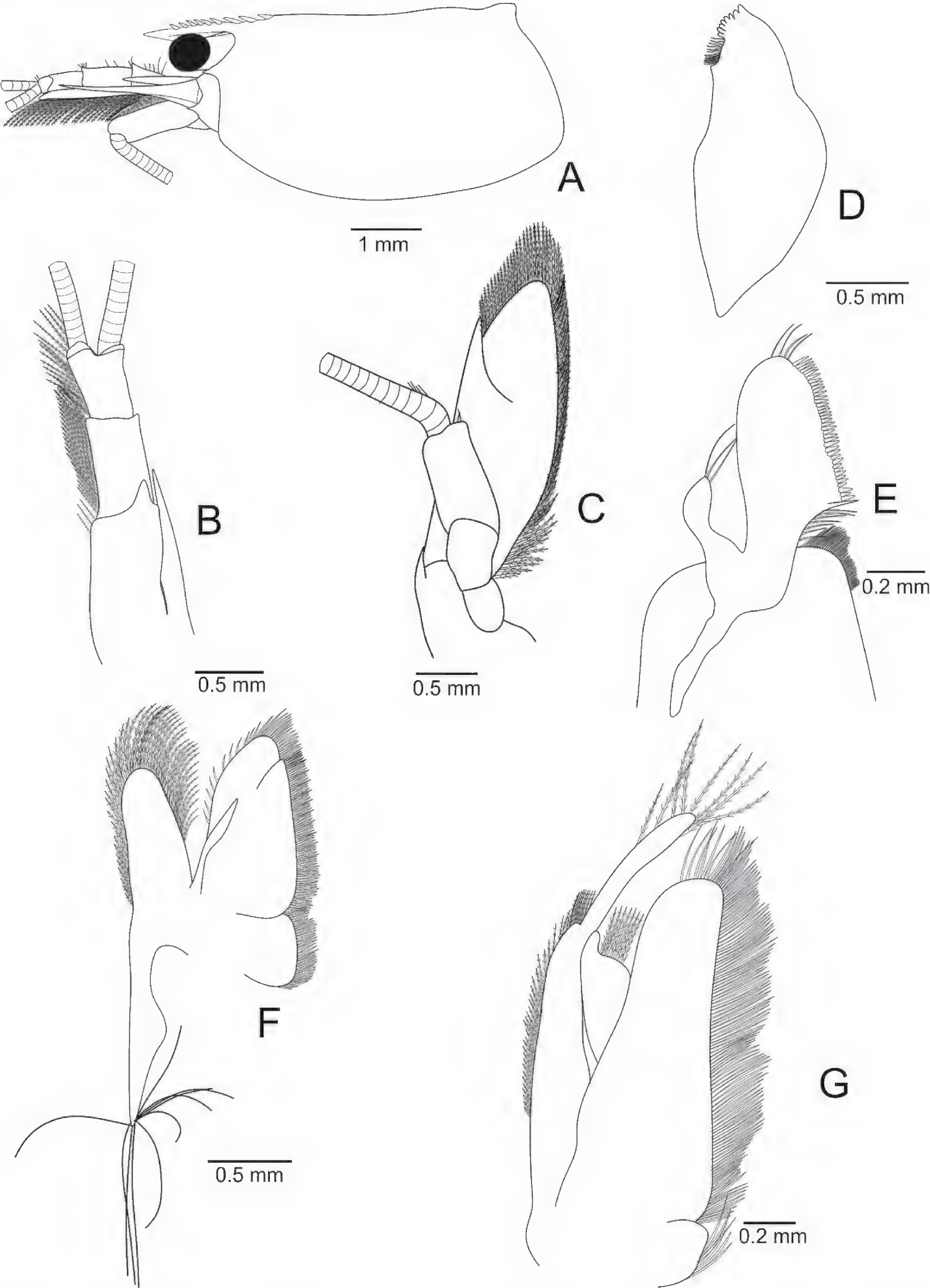


Figure 11. *Caridina huangi* Hou, Zhang & Guo, sp. nov. **A.** Holotype male (FU5727001); **B–G.** Paratype male (FU5727002): **A.** Cephalothorax; **B.** Antennular; **C.** Antenna; **D.** Mandible; **E.** Maxillula; **F.** Maxilla; **G.** First maxilliped.

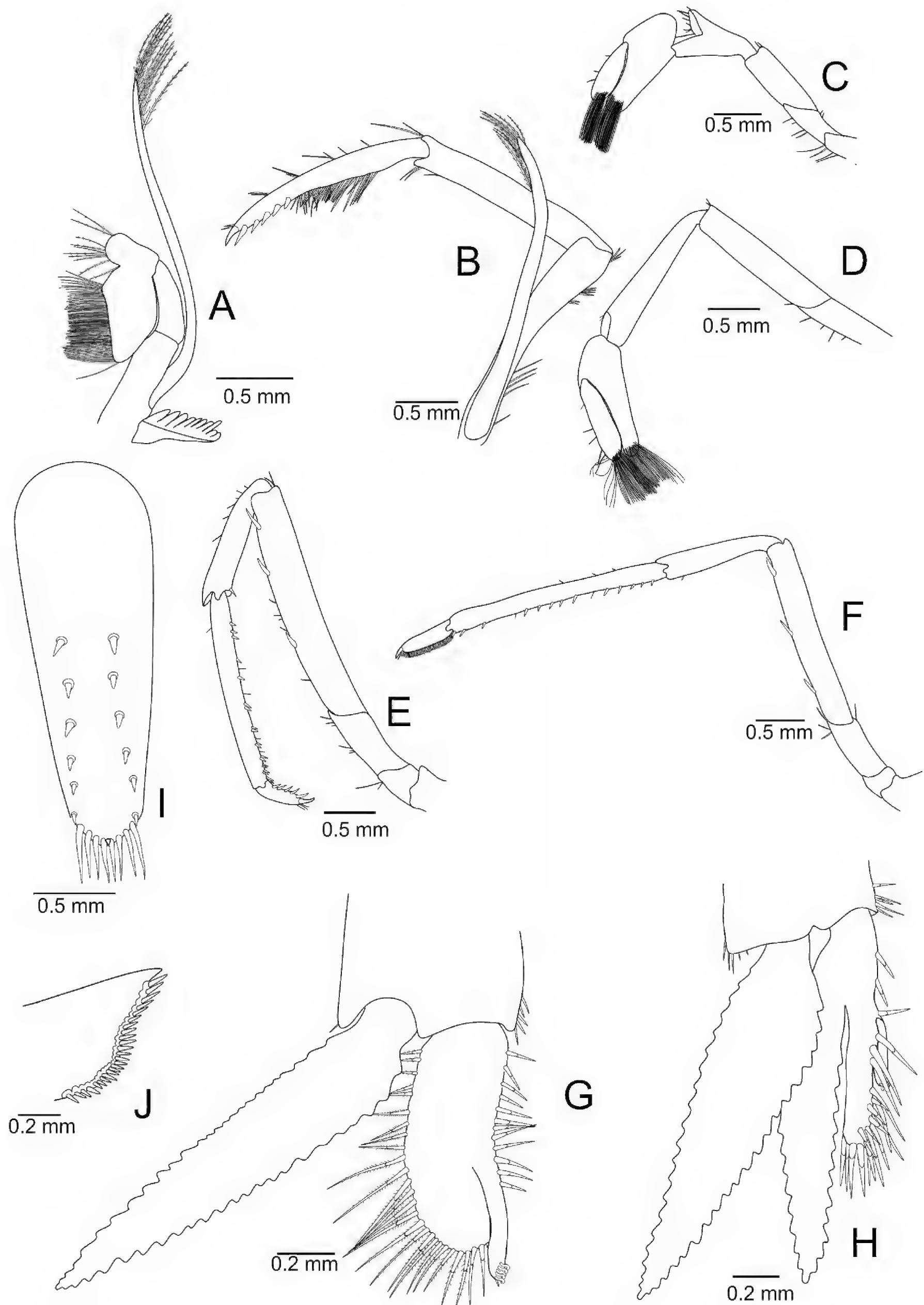


Figure 12. *Caridina huangi* Hou, Zhang & Guo, sp. nov. A–J. Paratype male (FU5727002): A. Second maxilliped; B. Third maxilliped; C. First pereopod; D. Second pereopod; E. Third pereopod; F. Fifth pereopod; G. First pleopod of the male; H. Second pleopod of the male; I. Telson; J. Uropodal diaeresis.

$0.85 \times 1.10\text{--}1.27$ mm vs. $0.93\text{--}1.07 \times 1.35\text{--}1.59$ mm in *C. mongziensis*).

In terms of the long stylocerite, the rostral morphology and armature, *Caridina huangi* sp. nov. closely resembles *C. qiongzongensis* sp. nov. (see remarks under *C. qiongzongensis* sp. nov.).

Molecular results. The intraspecific p-distances of COI of the new species were 0%–0.4%. The new species is most similar in genetic divergence (p-distance) to *C. brevilineata* sp. nov. (6.0%) and *C. hepingensis* sp. nov. (6.4%–6.6%). According to molecular analysis, the distance between the new species and *C. clinata* is 11.1%–11.8%. The intraspecific p-distances of 16SrRNA of the new species were 0%. The new species is most similar in genetic divergence (p-distance) to *C. hepingensis* sp. nov. (1.6%) and *C. qiongzongensis* sp. nov. (2.2%–2.5%). According to molecular analysis, the distance between the new species and *C. clinata* is 3.6%–4.6% (Fig. 21, Suppl. materials 1, 2).

Coloration. Body translucent. The surface of the cephalothorax is covered with fine spots. The middle part of the abdominal carapace has a row of small spots, and the abdominal margin has 3–4 fine vertical stripes. (Fig. 2E).

Etymology. The new species is named after its discoverer Mr. Huang.

Ecological notes. *C. huangi* sp. nov. was collected from site 8. At site 8, the stream measured 0.5–1.0 m in width and 0.3–0.5 m in depth, and its substrate consisted of rock, leaf litter, and aquatic plants. The shrimps lived densely among leaf litter and marginal vegetation, exhibiting high population density. The stream water was immediately flowing (Fig. 2E, Table 1).

Distribution. Only occurring in Heping Town, Qiongzong County, Hainan Island.

Caridina hepingensis Hou, Zhang & Guo, sp. nov.

<https://zoobank.org/E7881726-1027-46FB-8ABF-DAADEDFA6FDF>
Figs 2F, 13, 14

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 4.6 mm, (FU5727008), Qiongzong County, 18°52'58"N, 110°0'55"E, al. 147 m, stn. 9, coll. WANG A. and HOU J. J., 15 Aug. 2023.

Paratypes: 1 ♂, cl 3.9 mm, (FU5727009); 1 ♂, cl 3.9 mm, (FU5727010); 1 ♂, cl 3.2 mm, (FU5727011); 1 ♂, cl 3.4 mm, (FU5727012); 2 ♂♂, cl 3.5–4.6 mm, (FU5727014); 1 ovigerous ♀, cl 5.0 mm, (FU5727013), same collection data as holotype.

Comparative material. *Caridina baoting* Cai, 2014. CHINA – Hainan Island • 1 ♂, cl 4.9 mm, (FU5723001); 1 ♂, cl 5.3 mm, (FU5723002); 1 ♂, cl 4.3 mm, (FU5723003); 1 ♀, cl 4.8 mm, (FU5723004); 1 ♀, cl 5.1 mm, (FU5723005), stream from Xiangshui Town, Baoting County, 18°36'20"N, 109°35'19"E, al. 361 m, coll. 2 Jan. 2024.

Description. **Body** (Fig. 2F): Small, slender and sub-cylindrical, males up to 4.6 mm cl, females up to

5.0 mm cl. Sixth abdominal somite 0.46–0.66 times as long as carapace.

Rostrum (Fig. 13A): Short, straight, reaching to the end of the eye to the end of the first segment of antennular peduncle; 0.2–0.3 of cl; usually unarmed, rarely armed dorsally with 1–3 teeth, and 0–1 teeth on carapace posterior to orbital margin, ventrally unarmed; rostral formula 0–1+0–2/0; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 13A): Well-developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 13A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 13B): Peduncle reaching slightly short of scaphocerite; stylocerite reaching 0.84–0.93 times as long as basal segment of antennular peduncle; basal segment shorter than combined length of second and third segments, 1.31–1.42 times as long as second segment; second segment 1.07–1.29 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 13C): Scaphocerite 2.9–3.2 times as long as wide, outer margin straight, asetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 13G): Palp of first maxilliped broadly triangular, ending in a bulbous tip.

Third maxilliped (Fig. 14B): Basal segment 1.09–1.49 times as long as penultimate segment; penultimate segment 0.80–0.96 times as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 4–5 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching to the end of second segment, distal margin with long plumose setae.

First pereopod (Fig. 14C): Chela 1.70–2.08 times as long as high, 1.27–1.49 times as long as carpus; movable finger 2.22–2.99 times as long as wide and 0.72–1.21 times as long as palm, setal brushes well-developed; carpus 1.33–1.67 times as long as wide, slightly excavated distally; merus 1.02–1.17 times as long as carpus.

Second pereopod (Fig. 14D): Chela 2.25–3.03 times as long as high, 0.67–1.06 times as long as carpus; movable finger 3.63–4.45 times as long as wide and 1.11–1.74 times as long as palm, setal brushes well-developed; carpus 3.49–5.51 times as long as wide, slightly excavated distally; merus 0.87–1.31 times as long as carpus.

Third pereopod (Fig. 14E): Dactylus 3.04–3.48 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 4–5 spiniform setae; propodus 3.28–3.91 times as long as dactylus, 7.98–9.62 times as long as wide; carpus 0.65–0.77 times as long as propodus; merus 1.71–1.99 times as long as carpus, with 3 spiniform setae on the posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

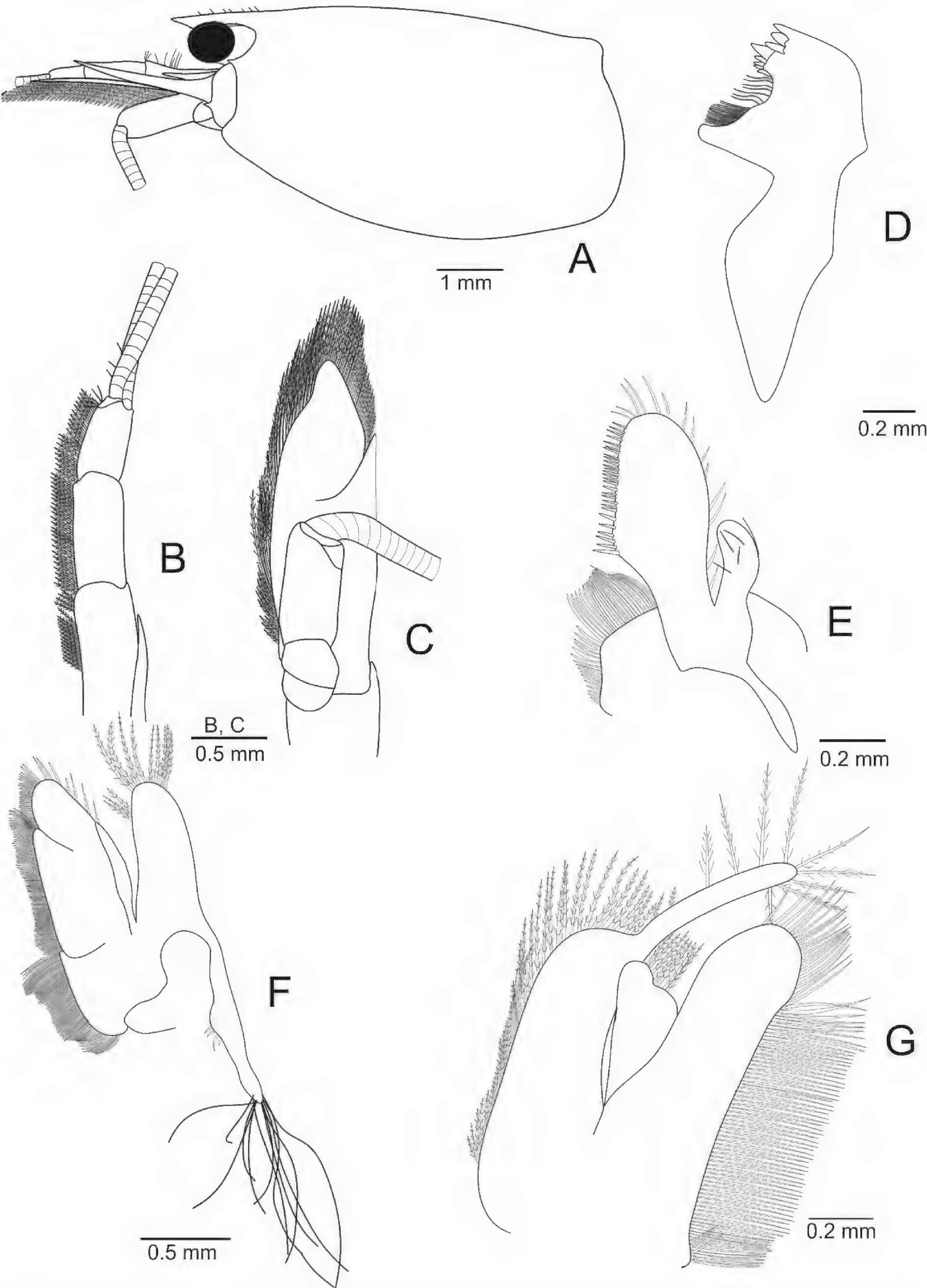


Figure 13. *Caridina hepingensis* Hou, Zhang & Guo, sp. nov. **A.** Holotype male (FU5727008); **B–G.** Paratype male (FU5727009): **A.** Cephalothorax; **B.** Antennular; **C.** Antenna; **D.** Mandible; **E.** Maxillula; **F.** Maxilla; **G.** First maxilliped.

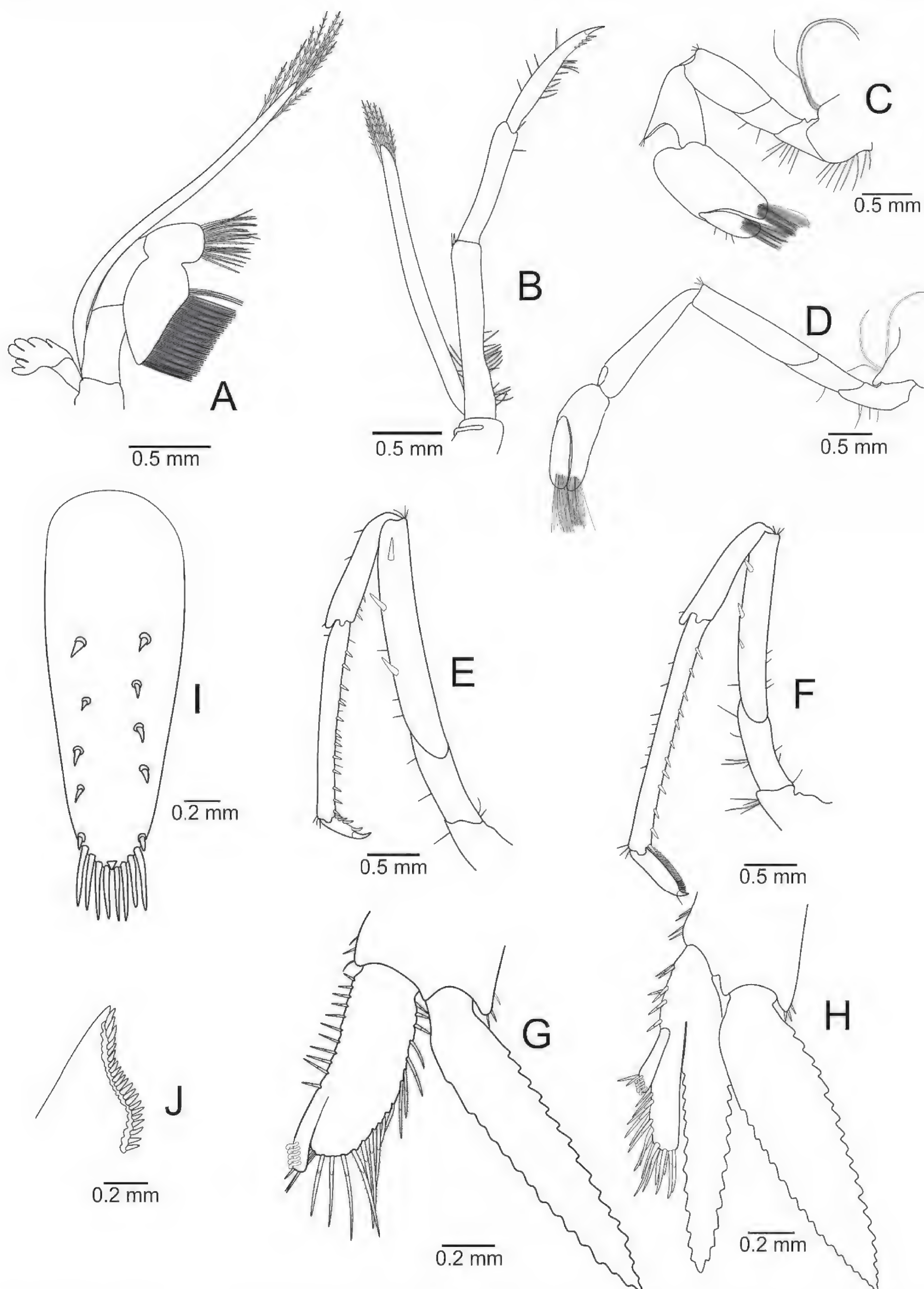


Figure 14. *Caridina hepingensis* Hou, Zhang & Guo, sp. nov. **A–I.** Paratype male (FU5727009); **J.** Paratype female (FU5727014): **A.** Second maxilliped; **B.** Third maxilliped; **C.** First pereopod; **D.** Second pereopod; **E.** Third pereopod; **F.** Fifth pereopod; **G.** First pleopod of the male; **H.** Second pleopod of the male; **I.** Telson; **J.** Uropodal diaeresis.

Fifth pereopod (Fig. 14F): Dactylus 3.27–4.00 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 36–57 spiniform setae; propodus 3.35–4.35 times as long as dactylus, 9.24–12.23 times as long as wide; carpus 0.55–0.66 times as long as propodus; merus 1.34–1.51 times as long as carpus, with 2–3 strong spines on the posterior margin.

First four pereopods with epipod.

First pleopod (Fig. 14G): Endopod in male 0.46–0.56 times as long as exopod, oblong-reniform, 2.53–3.25 times as long as distally wide, tip rounded, inner margin slightly straight, outer margin slightly convex, long pap-pose setae on outer and distal margins, medium-length setae on inner margin; appendix interna well-developed, arising from distal 0.33 of endopod, reaching slightly beyond end of endopod, distally with cincinuli.

Second pleopod (Fig. 14H): Appendix masculina rod-shaped, slightly thicker centrally, narrower distally, reaching 0.64–0.73 length of exopod, some short spiniform setae on basal part, and inner margin and tip bearing two rows of long spiniform setae; appendix interna well-developed, reaching 0.48–0.51 length of appendix masculina, distally with cincinuli.

Telson (Fig. 14I): Tapering posterior, with a projection, with 4 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin with 4 pairs of intermedial spiniform setae, two outer pairs subequal in length and slightly shorter than two middle pairs. Exopodite of uropod (Fig. 14J) bears a series of 19–23 movable spinules along diarsis.

Eggs: 0.67–0.80 mm × 1.10–1.20 mm in diameter.

Remarks. *Caridina hepingensis* sp. nov., indeed resembles *C. haivanensis* Do & Dang, 2010 by the form and armature of the rostrum, the shape of sexual appendages, and the proportions between the joints of the second, third, and fifth pereopods. However, it can be separated from *C. haivanensis* by the stouter carpus of the first pereopod (1.33–1.67 times as long as wide vs. 2.19 times in *C. haivanensis*); the palp of first maxilliped with a bulbous tip (vs. absent a bulbous tip in *C. haivanensis*); and among the four pairs of spiniform setae on the posterior margin of the telson, the two outer pairs are of subequal length and slightly shorter than the two middle pairs (vs. the three medial pairs being subequal in length and distinctly shorter than the outermost pair in *C. haivanensis*).

Caridina hepingensis sp. nov. superficially resembles *C. baoting* Cai, 2014 (also occurs on Hainan, the distance approximately 60 km) in the short rostrum and the proportions between the joints of pereopods. However, it differs from the latter species by the rostrum ventrally unarmed (vs. with 1–2 teeth in *C. baoting*); the slightly broader scaphocerite (2.9–3.2 times as long as wide vs. 3.4 times in *C. baoting*); and the slightly small eggs (0.67–0.80 × 1.10–1.20 mm vs. 0.80 × 1.40 mm in *C. baoting*).

Although *Caridina hepingensis* sp. nov. and *C. huangi* sp. nov. are distributed in the same town, they inhabit two unconnected streams approximately 10 km apart. *Caridina hepingensis* sp. nov. is easily separated from *C. huangi*

by the shorter stylocerite (not beyond to the end of first segment vs. reaching to the second segment in *C. huangi* sp. nov.), the fewer teeth on rostrum (dorsally with 0–2 teeth and ventrally with 0 tooth vs. dorsally with 9–11 teeth and ventrally with 1 tooth in *C. huangi* sp. nov.);

Molecular results. The intraspecific p-distances of COI of the new species were 0%. The new species is most similar in genetic divergence (p-distance) to *C. huangi* sp. nov. (6.6%) and *C. brevilineata* sp. nov. (6.6%). According to molecular analysis, the distance between the new species and *C. clinata* is 12.5%–13.0%, the distance between the new species and *C. haivanensis* is 12.2%. The intraspecific p-distances of 16SrRNA of the new species were 0%. The new species is most similar in genetic divergence (p-distance) to *C. huangi* sp. nov. (1.6%) and *C. qiongzongensis* sp. nov. (1.6%–1.8%). According to molecular analysis, the distance between the new species and *C. clinata* is 3.9%–5.3%, the distance between the new species and *C. haivanensis* is 4.3% (Fig. 21, Suppl. materials 1, 2).

Coloration. Body is translucent reddish-brown. The surface of the cephalothorax is covered with fine spots. The middle part of the abdominal carapace has a row of spots, and the abdominal margin has 3–4 fine vertical stripes. The dorsal side of the third segment has a vertical stripe extending to the 1/2 of the segment. (Fig. 2F).

Etymology. The new species is named after its type locality name: Heping Town.

Ecological notes. *C. hepingensis* sp. nov. was collected from site 9. At site 9, the stream measured 0.3–0.4 m in width and 0.2–0.3 m in depth, and its substrate consisted of rock and sand. The shrimps lived among rocks, exhibiting high population density. The stream water was slow-flowing (Fig. 2F, Table 1).

Distribution. Only occurring in Heping Town, Qiongzong County, Hainan Island.

Caridina fontinalis Hou, Zhang & Guo, sp. nov.

<https://zoobank.org/64DEAD4B-2FBC-46BB-A9AA-D3711357AA36>

Figs 2G, 15, 16

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 2.4 mm, (FU5700001), Haikou City, 19°55'4"N, 110°24'45"E, al. 16 m, stn. 10, coll. WANG G. Y. and HOU J. J., 17 Jan. 2025.

Paratypes: 1 ♂, cl 2.7 mm, (FU5700002), 1 ♂, cl 2.7 mm, (FU5700003); 1 ovigerous ♀, cl 2.4 mm, (FU5700004), 1 ♀, cl 3.4 mm, (FU5700005), same collection data as holotype.

Description. **Body** (Fig. 2G): Small, slender and sub-cylindrical, males up to 2.7 mm cl, females up to 3.4 mm cl. Sixth abdominal somite 0.44–0.48 times as long as carapace.

Rostrum (Fig. 15A): Straight, reaching to the end of the first segment to the end of the second segment of the antennular peduncle; 0.3–0.4 of cl; armed dorsally with 9–11 teeth, including 3–5 on carapace posterior to orbital

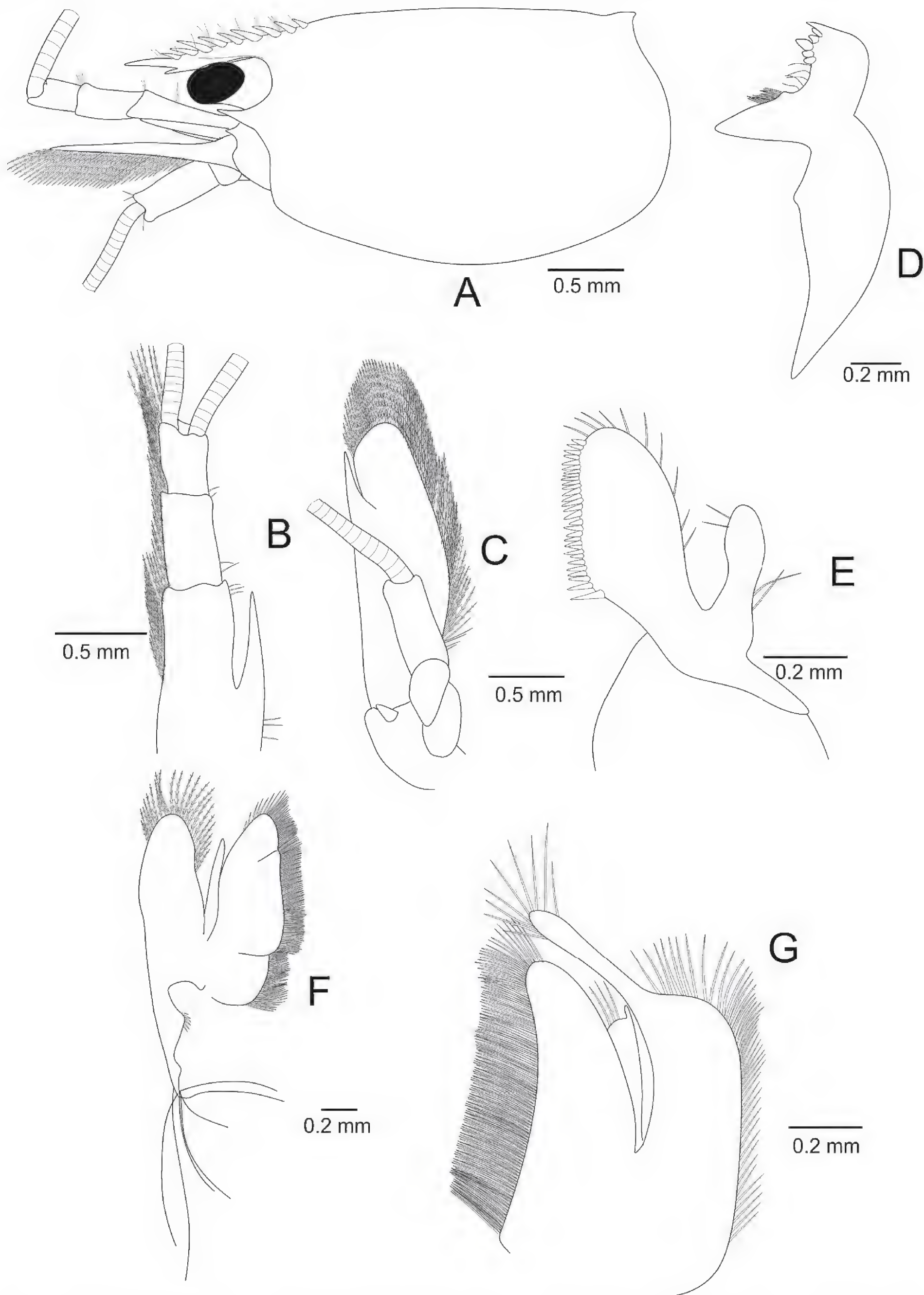


Figure 15. *Caridina fontinalis* Hou, Zhang & Guo, sp. nov. **A.** Holotype male (FU5700001); **B–G.** Paratype female (FU5700005): **A.** Cephalothorax; **B.** Antennular; **C.** Antenna; **D.** Mandible; **E.** Maxillula; **F.** Maxilla; **G.** First maxilliped.

margin, ventrally with 1 tooth; rostral formula 3–5+6/1; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 15A): Well-developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 15A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 15B): Peduncle reaching slightly short of scaphocerite; stylocerite reaching 0.76–0.96 times as long as basal segment of antennular peduncle; basal segment shorter than combined length of second and third segments, 1.70–1.77 times as long as second segment; second segment 1.35–1.66 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 15C): Scaphocerite 3.1 times as long as wide, outer margin straight, aetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 15G): Palp of first maxilliped broadly triangular, ending in finger-like projection.

Third maxilliped (Fig. 16B): Basal segment 0.95–1.06 times as long as penultimate segment; penultimate segment 0.85–0.94 times as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 5–6 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching beyond middle of second segment, distal margin with long plumose setae.

First pereopod (Fig. 16C): Chela 1.88–2.27 times as long as high, 1.26–1.44 times as long as carpus; movable finger 2.37–3.33 times as long as wide and 0.86–0.93 times as long as palm, setal brushes well-developed; carpus 1.36–2.11 times as long as wide, slightly excavated distally; merus 0.95–1.13 times as long as carpus.

Second pereopod (Fig. 16D): Chela 2.31–2.49 times as long as high, 0.78–0.84 times as long as carpus; movable finger 3.59–4.50 times as long as wide and 1.28–1.80 times as long as palm, setal brushes well developed; carpus 4.64–6.23 times as long as wide; slightly excavated distally, merus 0.81–0.92 times as long as carpus.

Third pereopod (Fig. 16E): Dactylus 3.59–4.49 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 4–6 spiniform setae; propodus 3.41–3.87 times as long as dactylus, 10.74–11.80 times as long as wide; carpus 0.67–0.68 times as long as propodus; merus 1.80–1.85 times as long as carpus, with 3–4 spiniform setae on posterior margin. Ischium sometimes with 1 spine on the posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

Fifth pereopod (Fig. 16F): Dactylus 4.37–5.39 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 22–32 spiniform setae; propodus 3.06–3.43 times as long as dactylus, 11.62–14.91 times as long as wide; carpus 0.56–0.57 times as long as propodus; merus 1.49–1.57

times as long as carpus, with 3–5 spiniform setae on posterior margin. Ischium sometimes with 1 spine on the posterior margin.

First four pereopods with epipod.

First pleopod (Fig. 16G, H): Endopod in male oblong-reniform, 0.49–0.61 times as long as exopod, 2.76–3.29 times as long as distally wide, distal end is distinctly narrower than the basal part, with a concave inner margin and a convex outer margin, long pappose setae on outer and distal margins, medium-length setae on inner margin; appendix interna well developed, arising from distal 0.25 of endopod, reaching slightly beyond end of endopod, distally with cincinuli.

Second pleopod (Fig. 16I): Appendix masculina rod-shaped, reaching 0.63–0.71 length of exopod, bearing sparse long spiniform setae; appendix interna well developed, reaching 0.72–0.78 length of appendix masculina, distally with cincinuli.

Telson (Fig. 16J): Tapering posterior, with a projection, with 3 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin with 3–4 pairs of intermedial spiniform setae. Exopodite of the uropod (Fig. 16K) bears a series of 12–16 movable spinules along diarsis.

Eggs: 0.56–0.67 mm × 0.83–0.97 mm in diameter.

Remark. *Caridina fontinalis* sp. nov. is a small species occurring in cool waters and stable flow conditions. *Caridina fontinalis* sp. nov. and *C. lanceifrons* co-occur at the same sampling site and share sexual appendage morphology and egg size. *Caridina fontinalis* sp. nov. is easily separated from *C. lanceifrons* by its shorter rostrum (reaching from the end of the first segment to the middle of the second segment of the antennular peduncle vs. extending to the end of the antennular peduncle in *C. lanceifrons*); fewer rostral teeth (dorsally with 9–11 teeth and ventrally with 1 tooth vs. dorsally 14–23 and ventrally 2–5 in *C. lanceifrons*); broader scaphocerite (3.1 times as long as wide vs. 3.9 times in *C. lanceifrons*); and slender carpus of the second pereopod (4.64–6.23 times as long as wide vs. 3.6–4.5 times in *C. lanceifrons*).

Caridina fontinalis sp. nov. is similar to *C. clinata* Cai et al., 1999, but differs by: more slender endopod of first pleopod (length of endopod 2.76–3.29 times width vs. 2.40–3.04 times in *C. clinata*); the spines of the appendix masculina of the second pleopod (the spines on the middle to apical regions of the appendix masculina of the second pleopod are relatively thinner vs. the spines on the middle to apical regions of the appendix masculina of the second pleopod are relatively thicker, longer, and more densely arranged in *C. clinata*); fewer dorsal teeth (9–11 vs. 12–21 in *C. clinata*); fewer comb-like spines on fifth pereopod dactylus (22–32 vs. 41–51 in *C. clinata*); the ventral surface of the merus on the third pereopod bears more spiniform setae (3–5 spiniform setae vs. 3 spiniform setae in *C. clinata*).

Caridina fontinalis sp. nov. is similar to *C. wenchangensis* sp. nov., but differs by the shape of endopod of first pleopod (the distal end is distinctly narrower than the bas-

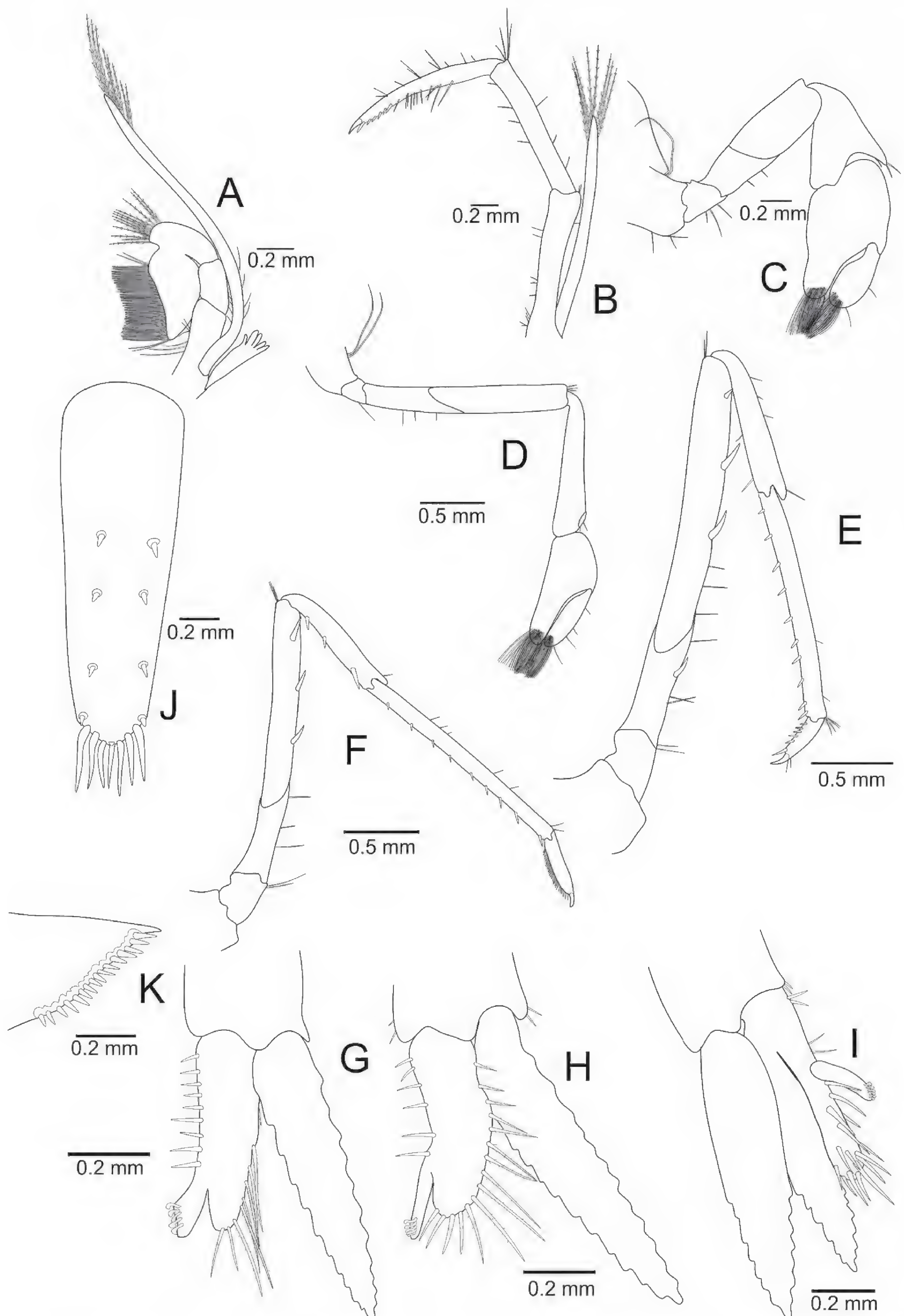


Figure 16. *Caridina fontinalis* Hou, Zhang & Guo, sp. nov. A–E, J, K. Paratype female (FU5700005); G, H. Holotype male (FU5700001); I. Paratype male (FU5700002): A. Second maxilliped; B. Third maxilliped; C. First pereopod; D. Second pereopod; E. Third pereopod; F. Fifth pereopod; G, H. First pleopod of the male; I. Second pleopod of the male; J. Telson; K. Uropodal diaeresis.

al part, with a concave inner margin and a convex outer margin vs. the distal end is as long as the basal part, with a relatively straight inner margin in *C. wenchangensis* sp. nov.); the spiniform setae of the appendix masculina of the second pleopod (the spiniform setae on the middle to apical regions of the appendix masculina of the second pleopod are relatively thinner vs. the spiniform setae on the middle to apical regions of the appendix masculina of the second pleopod are relatively thicker, longer, and more densely arranged in *C. wenchangensis* sp. nov.); fewer dorsal teeth (armed dorsally with 9–11 teeth, ventrally with 1 tooth vs. armed dorsally with 12–15 teeth, ventrally with 2–4 teeth in *C. wenchangensis* sp. nov.); the ventral surface of the merus on the third pereopod bears more spiniform setae (3–5 spiniform setae vs. 3–4 spiniform setae in *C. wenchangensis* sp. nov.).

Molecular results. According to the COI sequence, the intraspecific p-distances of COI of the new species were 0%–0.2%. The new species is most similar in genetic divergence (p-distance) to *C. tunchengensis* sp. nov. (5.3%–5.7%) and *C. wenchangensis* sp. nov. (11.2%–11.5%). According to molecular analysis, the distance between the new species and *C. clinata* is 11.7%–11.9%. According to the 16SrRNA sequence, the intraspecific p-distances of 16SrRNA of the new species were 0%–0.7%. The new species is most similar in genetic divergence (p-distance) to *C. tunchengensis* sp. nov. (1.6%–2.7%) and *C. clinata* (2.5%–3.6%). According to molecular analysis, the distance between the new species and *C. wenchangensis* sp. nov. is 4.6%–5.5% (Fig. 21, Suppl. materials 1, 2).

Coloration. Eyes reddish-brown; body semi-transparent; abdomen with faint black speckles (Fig. 2G).

Etymology. The name originates from their type locality, referring to their habitat at the spring's outlet, with “fontinalis” meaning “spring-dweller” in reference to their dwelling place near the water source.

Ecological notes. *C. fontinalis* sp. nov. was collected from site 10. At site 10, the stream measured 0.1–0.2 m in width and 0.1 m in depth, and its substrate consisted of rock and mud. The shrimps lived among rocks, with a low population density. The spring water was slowly flowing (Fig. 2G, Table 1).

Distribution. Only occurring in the type locality, Qiongsan District, Haikou City, Hainan Island.

Caridina tunchengensis Hou, Chen & Guo, sp. nov.

<https://zoobank.org/EF466739-7C57-4E6F-B4C2-F8FEBCA851CE>

Figs 2H, 17, 18

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 3.9 mm, (FU5700001), Tuncheng Town, Tunchang County, 19°28'23"N, 110°6'21"E, al. 181 m, stn. 11, coll. WANG G. Y. and HOU J. J., 18 Jan. 2025.

Paratypes: 1 ♂, cl 4.2 mm, (FU5716002); 1 ♂, cl 3.8 mm, (FU5716003); 1 ♂, cl 3.7 mm, (FU5716004); 1 ♂, cl 4.3 mm, (FU5716005); 1 ♀, cl 3.9 mm, (FU5716006),

1 ovigerous ♀, cl 4.4 mm, (FU5716007), same collection data as holotype.

Description. **Body** (Fig. 2H): Small, slender and sub-cylindrical, males up to 4.3 mm cl, females up to 4.4 mm cl. Sixth abdominal somite 0.40–0.51 times as long as carapace.

Rostrum (Fig. 17A): Short, straight, reaching from not beyond the eye to beginning of second segment of antennular peduncle; 0.2–0.3 of cl; armed dorsally with 3–13 teeth, including 0–5 on carapace posterior to orbital margin, ventrally with 1–2 teeth; rostral formula 0–5+3–8/1–2; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 17A): Well-developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 17A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 17B): Stylocerite reaching 0.79–0.90 times as long as basal segment of antennular peduncle; basal segment shorter than combined length of second and third segments, 1.46–1.74 times as long as second segment; second segment 1.16–1.40 times as long as third segments; all segments with marginal plumose setae.

Antenna (Fig. 17C): Scaphocerite 3.3 times as long as wide, outer margin straight, asetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 17G): Palp of first maxilliped broadly triangular, ending with no finger-like projection.

Third maxilliped (Fig. 18B): Basal segment 1.07–1.17 times as long as penultimate segment; penultimate segment 0.97–1.02 times as long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 5–6 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching the middle of second segment, distal margin with long plumose setae.

First pereopod (Fig. 18C): Chela 1.79–2.26 times as long as high, 1.21–1.34 times as long as carpus; movable finger 2.08–2.77 times as long as wide and 0.71–1.33 times as long as palm, setal brushes well developed; carpus 1.38–1.85 times as long as wide, slightly excavated distally; merus 1.03–1.11 times as long as carpus.

Second pereopod (Fig. 18D): Chela 2.22–3.15 times as long as high, 0.66–0.76 times as long as carpus; movable finger 2.85–4.37 times as long as wide and 1.07–1.47 times as long as palm, setal brushes well developed; carpus 5.17–5.66 times as long as wide, slightly excavated distally; merus 0.88–0.99 times as long as carpus.

Third pereopod (Fig. 18E): Dactylus 2.95–3.96 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 5–7 spiniform setae; propodus 3.04–4.24 times as long as dactylus, 8.13–10.05 times as long as wide; carpus 0.67–0.82 times as long as propodus; merus 1.42–1.96 times as long as carpus, with 3 spiniform setae on the posterior margin.

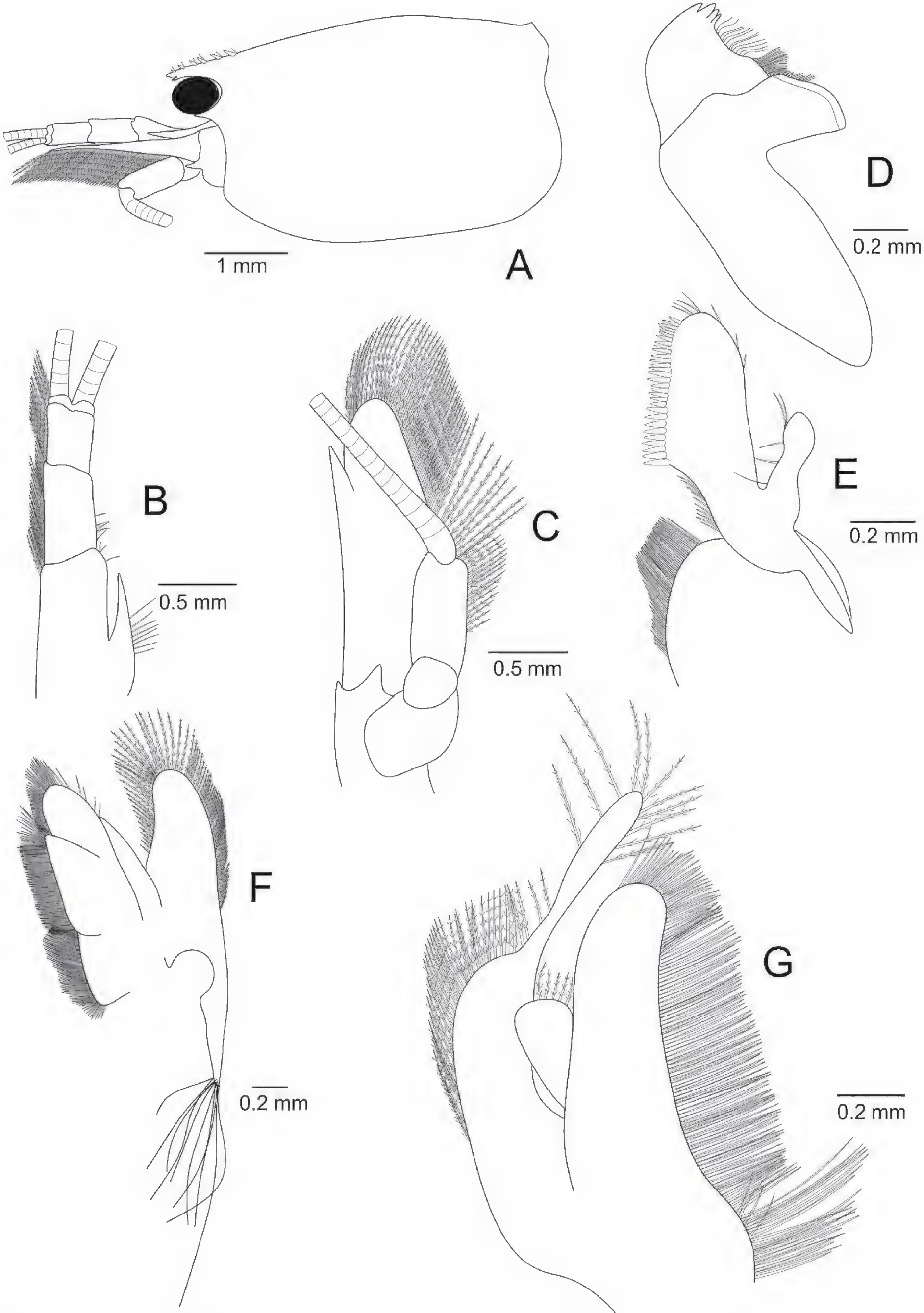


Figure 17. *Caridina tunchengensis* Hou, Chen & Guo, sp. nov. **A.** Holotype male (FU5716001); **B–G.** From paratype male (FU5716003): **A.** Cephalothorax; **B.** Antennular; **C.** Antenna; **D.** Mandible; **E.** Maxillula; **F.** Maxilla; **G.** First maxilliped.

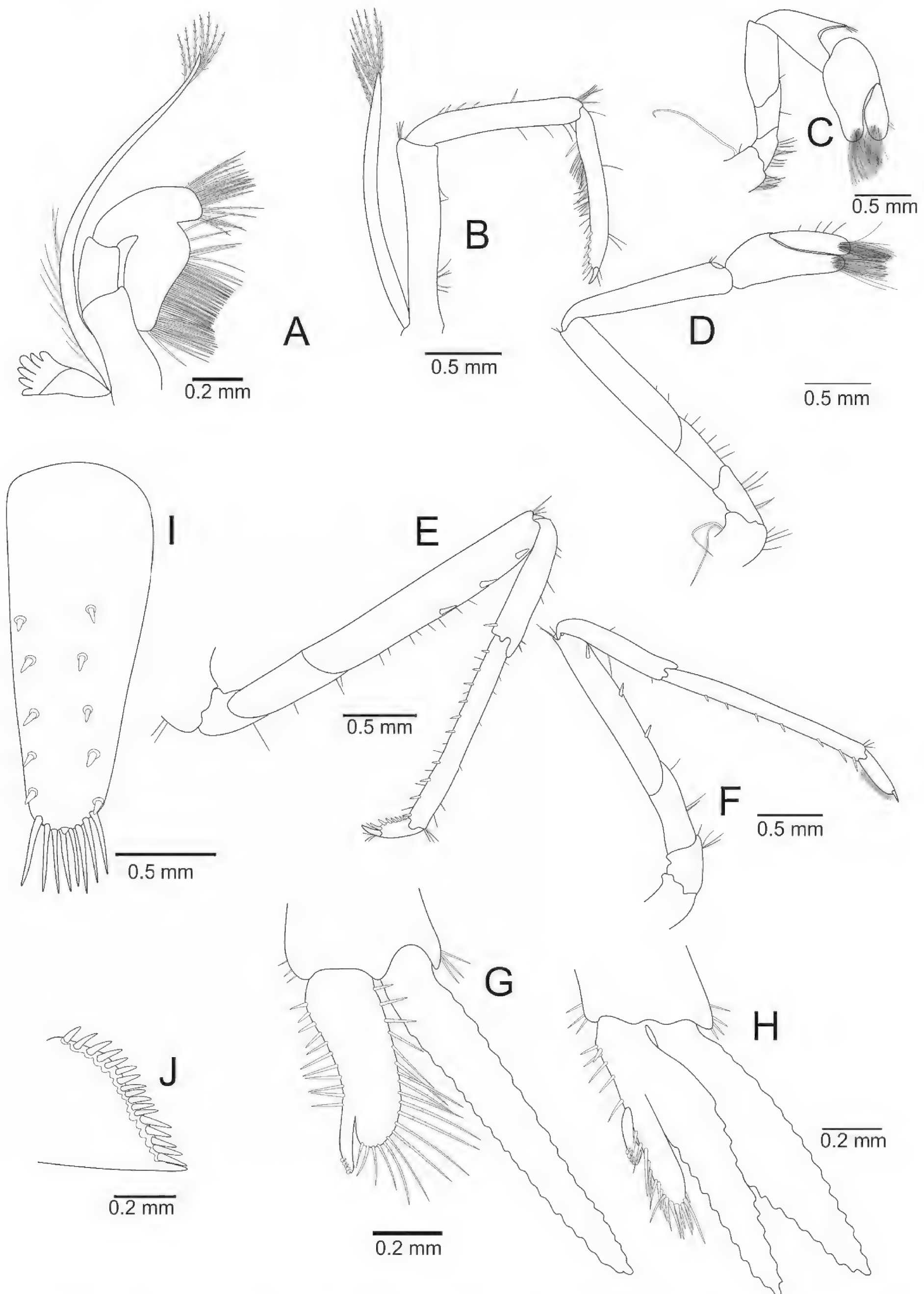


Figure 18. *Caridina tunchengensis* Hou, Chen & Guo, sp. nov. A–G. Paratype male (FU5716003): A. Second maxilliped; B. Third maxilliped; C. First pereopod; D. Second pereopod; E. Third pereopod; F. Fifth pereopod; G. First pleopod of the male; H. Second pleopod of the male; I. Telson; J. Uropodal diaeresis.

Ischium sometimes with 1 small movable spiniform setae on the posterior margin.

Third and fourth pereopods with 1 spine on ischium.

Fifth pereopod (Fig. 18F): Dactylus 3.37–4.62 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 36–42 spiniform setae; propodus 3.37–4.18 times as long as dactylus, 9.63–12.61 times as long as wide; carpus 0.51–0.61 times as long as propodus; merus 1.42–1.63 times as long as carpus, with 3 spiniform setae on the posterior margin.

First pleopod (Fig. 18G): Endopod reaching 0.42–0.45 times as long as exopod, oblong-reniform, 2.46–2.58 times as long as distally wide, terminal width subequal to basal width; inner margin concave, outer margin convex, long pappose setae on outer and distal margins, medium-length setae on inner margin; appendix interna well developed, arising from distal 0.2 of endopod, reaching slightly beyond the end of endopod, distally with cincinnuli.

Second pleopod (Fig. 18H): Appendix masculina rod-shaped, reaching 0.63–0.64 length of endopod; with some short spiniform setae on outer surface and some long and stout spiniform setae on distal surface; appendix interna reaching 0.50–0.56 length of appendix masculina.

Telson (Fig. 18I): With 4 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorso-laterally; posterior margin triangular, with 3–4 pairs of intermedial plumose setae, lateral plumose setae slightly longer, intermediate plumose setae subequal. Exopodite of the uropod (Fig. 18J) bears a series of 17–22 movable spinules along diarsis.

Eggs: 0.71–0.78 mm × 1.09–1.23 mm in diameter.

Remark. *Caridina tunchengensis* sp. nov. is similar to *C. clinata* Cai et al., 1999, but differs by: shorter and stouter endopod of first pleopod (length 2.46–2.58 times width vs. 2.40–3.04 times in *C. clinata*); fewer dorsal and ventral rostral teeth (3–13 dorsal, 1–2 ventral vs. 12–21 dorsal, 1–5 ventral in *C. clinata*); fewer spiniform setae on fifth pereopod dactylus (36–42 spiniform setae vs. 41–51 spiniform setae in *C. clinata*); absence of digitiform process on first maxilliped exopod (present in *C. clinata*); palp of first maxilliped (ending with no finger-like projection vs. ending with a finger-like projection in *C. clinata*).

Caridina tunchengensis sp. nov. is similar to *C. fontinalis* sp. nov., but differs by: shorter first pleopod endopod (0.42–0.45 times as long as exopod vs. 0.49–0.61 times as long as exopod in *C. fontinalis* sp. nov.); more uropodal exopod spines (17–22 vs. 12–16 in *C. fontinalis* sp. nov.); fewer merus spines on third and fifth pereopods (3 vs. 3–5 in *C. fontinalis* sp. nov.); palp of first maxilliped (absence of digitiform process on first maxilliped exopod vs. with a digitiform process on first maxilliped exopod in *C. fontinalis* sp. nov.).

Molecular results. According to the COI sequence, the intraspecific p-distances of COI of the new species were 0%–0.2%. The new species is most similar in genetic divergence (p-distance) to *C. fontinalis* sp. nov. (5.3%–5.7%) and *C. wenchangensis* sp. nov. (9.1%–9.4%). According to molecular analysis, the distance between the

new species and *C. clinata* is 9.4%–9.6%. According to the 16SrDNA sequence, the intraspecific p-distances of 16SrDNA of the new species were 0.4%–1.1%. The new species is most similar in genetic divergence (p-distance) to *C. fontinalis* sp. nov. (1.6%–2.7%) and *C. clinata* (2.7%–3.2%). According to molecular analysis, the distance between the new species and *C. wenchangensis* sp. nov. is 5.6%–5.8% (Fig. 21, Suppl. materials 1, 2).

Coloration. Eyes reddish-brown; body translucent; posterior carapace margin with a black longitudinal stripe; mid and posterior abdominal segments with faint black speckles. (Fig. 2H).

Etymology. The name is derived from its type locality, Tuncheng Town.

Ecological notes. *C. tunchengensis* sp. nov. was collected from site 11. At site 11, the stream measured 0.5–1.0 m in width and 0.2–0.3 m in depth, and its substrate consisted of rock, mud, leaf litter, and aquatic plants. The shrimps lived among leaf litter and marginal vegetation, exhibiting high population density. The stream water was slow-flowing (Fig. 2H, Table 1).

Distribution. Only occurring in the type locality, Tuncheng Town, Tunchang County, Hainan Island.

Caridina brevilineata Hou, Zhang & Guo, sp. nov.

<https://zoobank.org/0422D73B-D490-444F-ADE4-D40618B01A6A>

Figs 21, 19, 20

Materials examined. CHINA – Hainan Island • **Holotype:** 1 ♂, cl 4.6 mm, (FU5714025), a stream from Hushan Town, Qionghai City, 19°6'42"N, 110°11'49"E, al. 61 m, stn. 12, coll. HUANG and HOU J. J., 1 May. 2025.

Paratypes: 1 ♂, cl 4.2 mm, (FU5714026); 1 ♂, cl 3.2 mm, (FU5714027); 1 ♀, cl 4.6 mm, (FU5714028), same collection data as holotype.

Description. **Body** (Fig. 2I): Small, slender and sub-cylindrical, males up to 4.6 mm cl, females up to 4.6 mm cl. Sixth abdominal somite 0.46–0.50 times as long as carapace.

Rostrum (Fig. 19A): Straight, reaching to not beyond eye to end of second segment of antennular peduncle; 0.2–0.5 of cl; armed dorsally with 3–11 teeth, including 2–3 on carapace posterior to orbital margin, ventrally with 0–2 teeth; rostral formula 2–3+1–8/0–2; lateral carina dividing rostrum into two unequal parts, continuing posteriorly to orbital margin.

Eyes (Fig. 19A): Well developed, on short ocular peduncle, cornea globular.

Carapace (Fig. 19A): Smooth, glabrous; antennal spine acute, fused with inferior orbital angle; pterygostomian margin broadly rectangular, slightly produced forward; pterygostomian spine absent.

Antennule (Fig. 19B): Stylocerite reaching 1.00–1.19 times as long as basal segment of antennular peduncle; basal segment shorter than combined length of second and third segments, 1.30–1.84 times as long as second segment, second segment 1.23–1.34 times as long as third segments; all segments with marginal plumose setae.

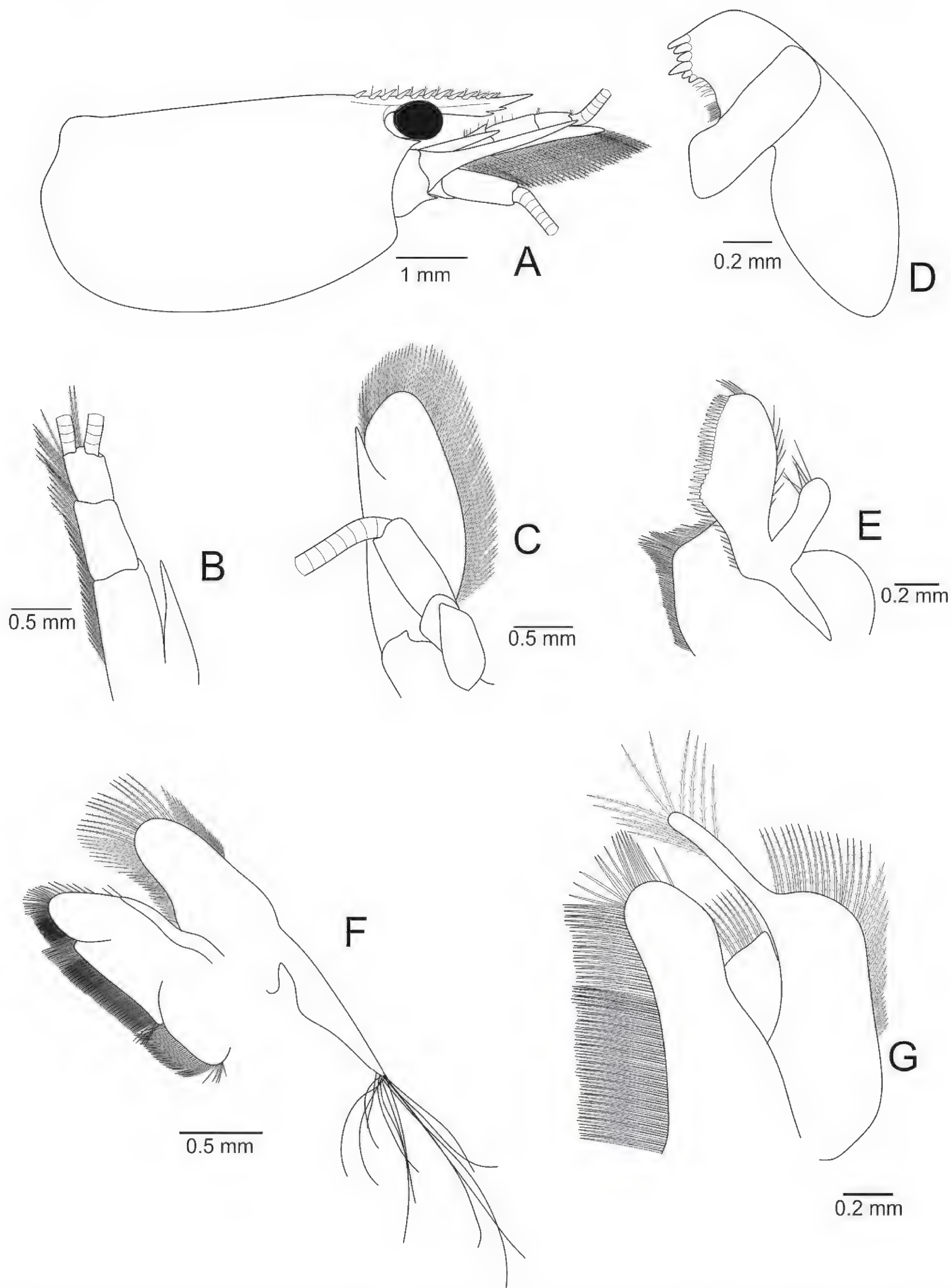


Figure 19. *Caridina brevilineata* Hou, Zhang & Guo, sp. nov. **A.** Holotype male (FU5714025); **B–G.** Paratype male (FU5714026): **A.** Cephalothorax; **B.** Antennular; **C.** Antenna; **D.** Mandible; **E.** Maxillula; **F.** Maxilla; **G.** First maxilliped.

Antenna (Fig. 19C): Scaphocerite 2.5–3.0 times as long as wide, outer margin straight, asetose, ending in a strong sub-apical spine, inner and anterior margins with long plumose setae.

First maxilliped (Fig. 19G): Palp of first maxilliped broadly triangular, ending with no finger-like projection.

Third maxilliped (Fig. 20B): Basal segment 1.25 times as long as penultimate segment; penultimate segment as

long as distal segment, ending in a large claw-like spine surrounded by simple setae, preceded by 6 thin spines on distal third of posterior margin, proximally a clump of long and short simple, serrate setae; exopod reaching beyond the beginning of second segment, distal margin with long plumose setae.

First pereopod (Fig. 20C): Chela 1.84–2.50 times as long as high, 1.23–1.41 times as long as carpus; movable finger 2.70–3.45 times as long as wide and 0.85–1.01 times as long as palm, setal brushes well developed; carpus 1.60–2.02 times as long as wide, slightly excavated distally; merus 1.00–1.33 times as long as carpus.

Second pereopod (Fig. 20D): Chela 2.61–3.27 times as long as high, 0.70–0.86 times as long as carpus; movable finger 3.82–4.08 times as long as wide and 1.31–1.76 times as long as palm, setal brushes well-developed; carpus 4.97–6.15 times as long as wide, slightly excavated distally; merus 0.81–1.01 times as long as carpus.

Third pereopod (Fig. 20E): Dactylus 3.58–3.93 times as long as wide, terminating in a prominent claw-like spine surrounded by simple setae, followed by 4–6 spiniform setae; propodus 3.43–4.04 times as long as dactylus, 10.48–11.67 times as long as wide; carpus 0.68–0.96 times as long as propodus; merus 1.73–1.88 times as long as carpus, with 2–3 spiniform setae on the posterior margin.

Fourth pereopod: Proportion and spination similar to third pereopod.

Fifth pereopod (Fig. 20F): Dactylus 3.44–4.01 times as long as wide, ending in prominent claw-like spine surrounded by simple setae, followed by a row of 29–52 spiniform setae; propodus 3.32–4.42 times as long as dactylus, 10.75–13.13 times as long as wide; carpus 0.33–0.61 times as long as propodus; merus 1.44–1.61 times as long as carpus, with 2–3 spiniform setae on posterior margin.

First pleopod (Fig. 20G): Endopod reaching 0.44–0.57 times as long as exopod, reniform leaf-shaped, terminal width subequal to basal width, 2.70 times as long as distally wide, inner margin relatively straight, outer margin slightly convex, long pappose setae on outer and distal margins, medium-length setae on inner margin; appendix interna well developed, arising from distal 0.2 of endopod, reaching slightly beyond the end of endopod, distally with cincinuli.

Second pleopod (Fig. 20H): Appendix masculina rod-shaped, reaching 0.63–0.72 length of exopod; some sparse long spines basal margin with 4 short spiniform setae, and inner margin and tip with robust spiniform setae; appendix interna well-developed, reaching 0.50–0.56 length of appendix masculina, distally with cincinuli.

Telson (Fig. 20I): With 6 pairs of short spiniform setae dorsally and one pair of short spiniform setae dorsolaterally; posterior margin triangular, with 3–4 pairs of intermedial spiniform setae, lateral spiniform setae slightly longer, intermediate spiniform setae subequal. Exopodite of the uropod (Fig. 20J) bears a series of 18–22 movable spinules along diarsis.

Remark. *Caridina brevilineata* sp. nov. is similar to *C. clinata* Cai et al., 1999, but differs by: the shape of endo-

pod of first pleopod (reniform leaf-shaped vs. oblong-reniform in *C. clinata*); fewer rostral teeth (3–11 dorsal, 0–2 ventral vs. 12–21 dorsal, 1–5 ventral in *C. clinata*); palp of first maxilliped (ending with no finger-like projection vs. ending with a finger-like projection in *C. clinata*).

Caridina brevilineata sp. nov. is similar to *C. tunchengensis* sp. nov., but differs by: slender endopod of first pleopod (2.70 times as long as wide vs. 2.46–2.58 times as long as wide in *C. tunchengensis* sp. nov.); the longer appendix masculina and appendix interna of male second pleopod (appendix masculina reaching 0.63–0.72 length of endopod, appendix interna reaching 0.50–0.56 length of appendix masculina vs. appendix masculina reaching 0.63–0.64 length of endopod, appendix interna reaching 0.50–0.56 length of appendix masculina in *C. tunchengensis* sp. nov.).

Caridina brevilineata sp. nov. is similar to *C. qiongzhongensis* sp. nov., but differs by: the spines on the appendix masculina of male second pleopod (sparser, thicker, and longer vs. shorter, denser, thinner in *C. qiongzhongensis* sp. nov.) the slender carpus of first pereopod (1.60–2.02 times as long as wide vs. 1.18–1.66 times as long as wide in *C. qiongzhongensis* sp. nov.); the slender carpus of second pereopod (4.97–6.15 times as long as wide vs. 4.13–4.90 times as long as wide in *C. qiongzhongensis* sp. nov.); the slender propodus of fifth pereopod (10.75–13.13 times as long as of wide vs. 9.38–12.47 times as long as wide in *C. qiongzhongensis* sp. nov.).

Molecular results. According to the COI sequence, the intraspecific p-distances of COI of the new species were 0%. The new species is most similar in genetic divergence (p-distance) to *C. huangi* sp. nov. (6.0%) and *C. hepingensis* sp. nov. (6.6%). According to molecular analysis, the distance between the new species and *C. clinata* is 12.0%–12.8%, the distance between the new species and *C. qiongzhongensis* sp. nov. is 7.3%–7.5%. According to the 16SrDNA sequence, the intraspecific p-distances of 16SrDNA of the new species were 0%–0.2%. The new species is most similar in genetic divergence (p-distance) to *C. qiongzhongensis* sp. nov. (2.5%–2.9%) and *C. hepingensis* sp. nov. (2.7%–2.9%). According to molecular analysis, the distance between the new species and *C. clinata* is 5.0%–5.8%, the distance between the new species and *C. huangi* sp. nov. is 3.2%–3.4% (Fig. 21, Suppl. materials 1, 2).

Coloration. Eyes reddish-brown; body translucent; the body surface is densely covered with small, fine spots. The plastron near the ventral margin has 5 distinct short stripes; the middle part of the plastron has a row of round spots; near the dorsal margin of the plastron, there is 1 thick, long vertical stripe at the end of the third segment, extending to 2/3 of the plastron (Fig. 2I).

Etymology. The name is derived from its pattern, and *brevilineata* means having short stripes.

Ecological notes. *C. brevilineata* sp. nov. was collected from site 12. At site 12, the stream measured 2.0–3.0 m in width and 0.5–1.0 m in depth, and its substrate consisted of big rocks, gravel, leaf litter, and aquatic plants. The shrimps lived among leaf litter and marginal vegetation,

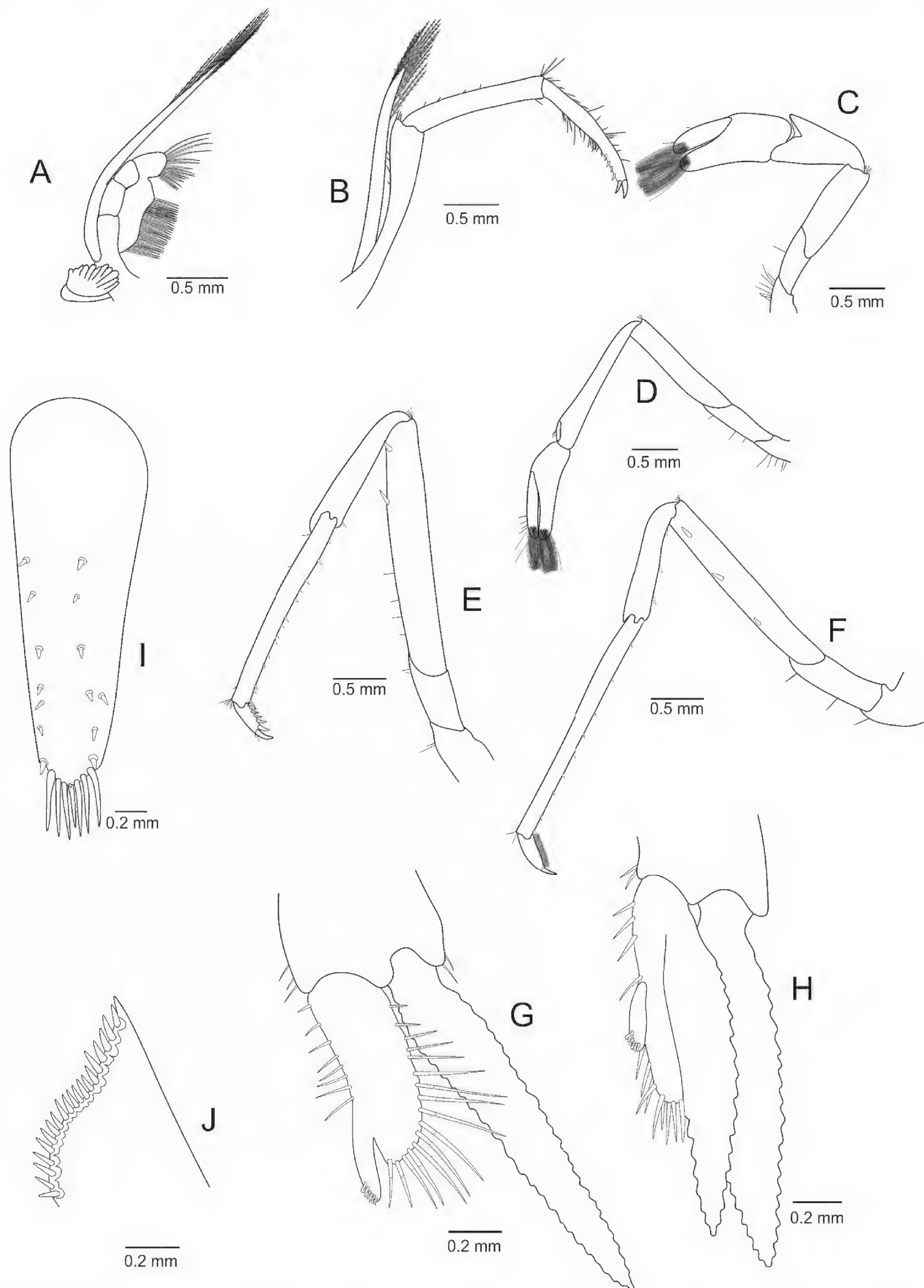
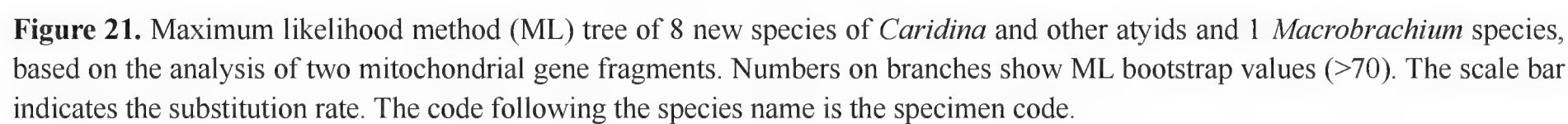


Figure 20. *Caridina brevilineata* Hou, Zhang & Guo, sp. nov. **A–G.** Paratype male (FU5714026): **A.** Second maxilliped; **B.** Third maxilliped; **C.** First pereopod; **D.** Second pereopod; **E.** Third pereopod; **F.** Fifth pereopod; **G.** First pleopod of the male; **H.** Second pleopod of the male; **I.** Telson; **J.** Uropodal diaeresis.



exhibiting low population density. The stream water was intermediately flowing (Fig. 2I, Table 1).

Distribution. Only occurring in the type locality, Qionghai City, Hainan Island.

Discussion

Perspectives on the taxonomy of *Caridina clinata* complex

The *Caridina clinata* species complex is a group of shrimp species distributed across Hainan (China) and Vietnam, sharing certain common characteristics in morphology, biology, ecology, and phylogeny. Morphologically, members of this complex are defined by four key diagnostic features: a relatively stout body, a short rostrum, an oblong-reniform endopod on the male first pleopod, and a rod-shaped appendix masculina on the male second pleopod. Biologically, the complex is characterized by producing a small number of large-sized eggs – a trait that enables direct larval development into benthic juveniles and completion of an exclusively freshwater life cycle.

Ecologically, these specialized landlocked species inhabit the middle-upper reaches of mountain streams. They typically occupy microhabitats with aquatic vegetation and leaf litter, occurring on diverse substrates (muddy, sandy, gravelly, and rocky bottoms) and showing a preference for slow to moderate water flow. Phylogenetic analyses based on 16S rRNA and mtDNA COI support the monophyly of the *C. clinata* complex, which comprises 9 distinct, well-supported clades. Among these, *C. clinata* ranges across China and Vietnam; *C. haivanensis* is restricted to Vietnam; the remaining seven newly described species are currently known only from Hainan Island, China: *C. wenchangensis* sp. nov., *C. qiongzhongensis* sp. nov., *C. huangi* sp. nov., *C. hepingensis* sp. nov., *C. fontinalis* sp. nov., *C. tunchengensis* sp. nov., and *C. brevilineata* sp. nov.

The sympatric occurrence of eight sister species in proximate sampling sites on Hainan Island implies reproductive isolation barriers. In the similar habitats of Hainan Island and Vietnam, the shared distribution of *C. clinata* may be attributed to the connectivity role of the Red River during glacial periods – which created favorable conditions for aquatic organisms to disperse from the Red River Delta to Hainan Island (Chen et al. 2019).

Previously attributed to *Caridina clinata* from Wuzhishan represent *C. caii* sp. nov.

Based on morphological and molecular analyses of specimens from Wuzhishan and their comparison with topotype specimens of *Caridina clinata* from Vietnam, our results reveal distinct morphological and genetic divergences between the Wuzhishan population and *C. clinata*. Consequently, this study reassigns the taxonomic status

of the Wuzhishan population as a new species, formally described herein as *Caridina caii* sp. nov., and further underscores the high degree of site-specific endemism within the Hainan Islands.

Phylogenetic analysis indicates that *Caridina caii* sp. nov. clusters within the *C. lanceifrons* species group. Notably, morphologically, *Caridina caii* sp. nov. is readily distinguished from its congener *C. minnanica* by a shorter rostrum with fewer ventral teeth and a long finger-like projection on the palp of the first maxilliped.

Conservation status of *Caridina* species in Hainan

Given the high vulnerability of these isolated atyid shrimps – restricted to the mid-upper reaches of Hainan’s streams – to anthropogenic impacts, field surveys suggest their primary threats derive from three human-induced activities: water contamination; habitat degradation/loss; and alien species invasion. Among these, habitat degradation, driven by both infrastructure development and agricultural expansion, is particularly severe. Hydraulic infrastructure for power generation and agricultural irrigation is widespread across Hainan’s rivers and streams (Fig. 22B), while the shrimps’ habitats are often confined to small streams surrounded by rubber and betel nut plantations (Fig. 22A). Intensive irrigation practices have depleted stream flow, with plantation owners installing temporary in-stream diversions during droughts, causing complete desiccation of mid-reach and lower-reach segments (Fig. 22D). Additionally, local villagers have erected pipelines across streams to extract water for domestic use, further fragmenting aquatic habitats. These activities have exacerbated habitat fragmentation by encroaching on stream corridors and disrupting vegetation cover critical to shrimp survival.

Collectively, these interconnected threats – habitat degradation from agriculture, infrastructure, and tourism; water contamination from agricultural chemicals; and emerging alien species invasion – inevitably degrade water quality, accelerate habitat fragmentation, and increase the risk of ecosystem collapse. Such scenarios disrupt shrimps’ physiological functions, reproductive viability, and migratory patterns, reducing species resilience and pushing populations toward decline or extinction.

Alien species invasion, the third major threat, poses understudied risks. As a well-recognized driver of biodiversity loss – via predation, resource competition, or disease transmission – three invasive species have been documented in our Hainan surveys: the crayfish *Cherax quadricarinatus* and two fish species, *Gambusia affinis* and *Oreochromis niloticus*. The two fish species are widely distributed, with stable, high-density populations in rivers and streams, and may coexist sympatrically with native shrimps in certain streams. However, their specific impacts on native shrimp populations and the overall biodiversity threat level remain undocumented, highlighting a critical research gap.

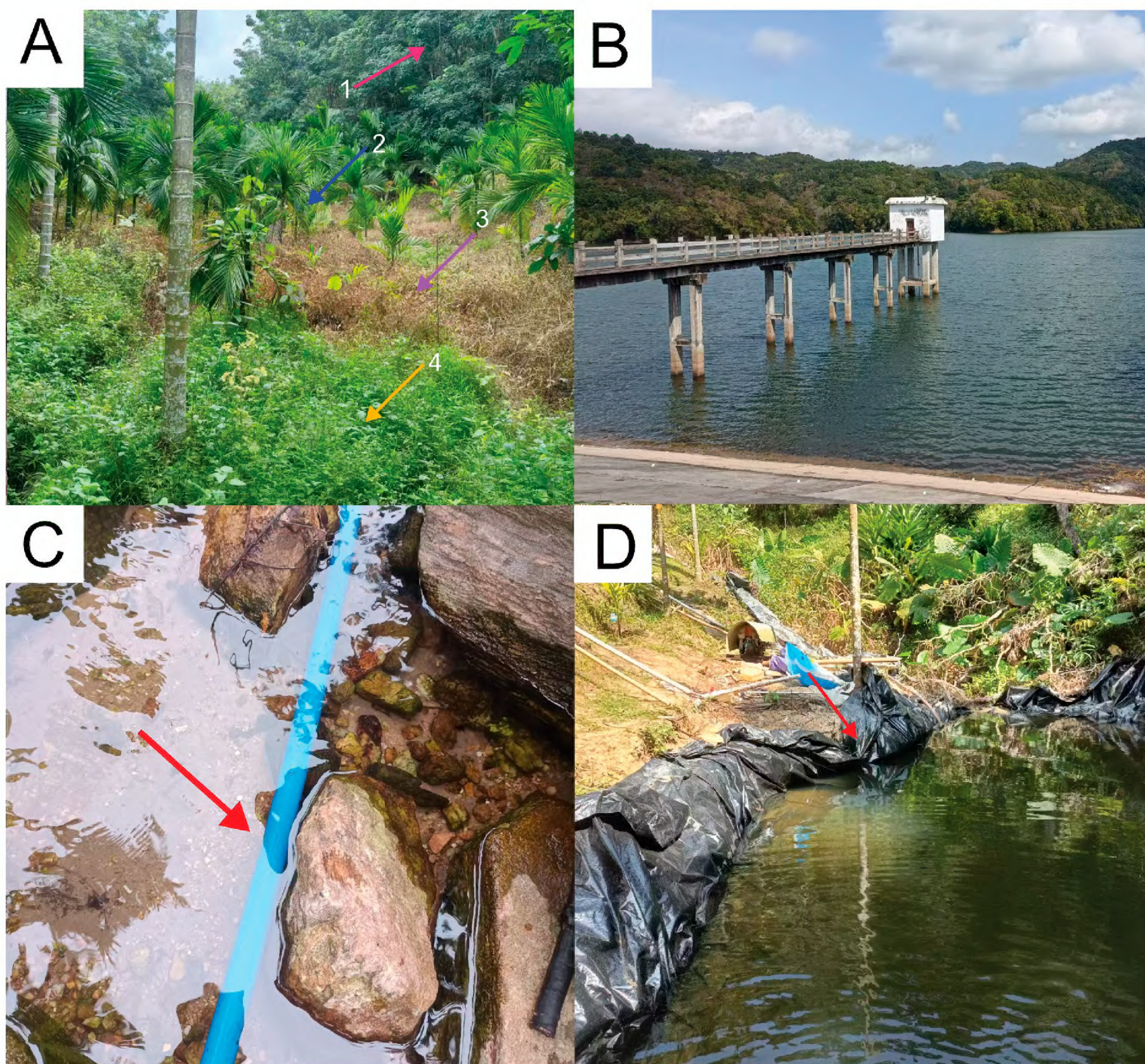


Figure 22. A. 1 are rubber trees planted on the mountain, 2 are planted betel nut trees, 3 is withered grass after herbicide spraying, and 4 is grassland without herbicide spraying; B. Water conservancy facilities used for power generation and agricultural irrigation; C. Water pumping pipes in the stream; D. Water interception and irrigation using plastic pools in the upper reaches of the stream.

The IUCN Red List of Threatened Species is widely recognized as a benchmark for assessing the conservation status of various organism groups. Based on IUCN guidelines, China has established national threatened species lists, including the Ministry of Agriculture and Rural Affairs of the PRC (MARA) Announcement No. 69, 2018: “List of Aquatic Wild Species under Special State Protection in China” https://www.gov.cn/zhengce/zhengceku/2018-12/31/content_5445504.htm and the National Forestry and Grassland Administration (NFGA) and the Ministry of Agriculture and Rural Affairs of the PRC (MARA) Joint Announcement No. 3, 2021: “List of National Key Protected Wild Animals” https://yyj.moa.gov.cn/gzdt/202102/t20210205_6361296.htm. These lists are essential for implementing China’s conservation strategies. However, *Caridina* species are largely overlooked in conservation efforts due to their small body size, a lack of historical population and distribution data, and their exclusion from national protection lists.

Eight newly described *Caridina* species are classified as Data Deficient (DD) under the IUCN Red List Categories and Criteria (<https://www.iucnredlist.org/>), as they are known solely from their type localities and lack data on broader geographic distribution. In the present study, we adopt the prior assessment of *C. clinata* as Data Deficient (DD) (De Grave and Cai 2013).

In response to these anthropogenic disturbances, regular monitoring of wild populations is imperative, alongside the implementation of public awareness campaigns that emphasize the ecological importance of freshwater shrimp biodiversity.

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Supplementary material 1

p-distance for COI for all the relevant species

Authors: Junjie Hou, Jiping Zhang, Bing Chen, Yixuan Zhang

Data type: xlsx

Explanation note: genetic distance of COI.

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Link: <https://doi.org/10.3897/zse.101.172207.suppl1>

Supplementary material 2

p-distance for 16S for all the relevant species

Authors: Junjie Hou, Jiping Zhang, Bing Chen, Yixuan Zhang

Data type: xlsx

Explanation note: genetic distance of 16S.

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